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THE ORGANIZATION, CONSTRUCTION AND MANAGEMENT OF HOSPITALS

WITH NUMEROUS PLANS AND DETAILS

BY

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THE ORGANIZATION OF HOSPITALS

INTRODUCTION.

Until very recently the construction of hospitals was almost a matter of accident, no one having given the subject any special attention. The people furnishing the funds for its construction were usually entirely innocent of any knowledge of the necessities in the case. The architect was chosen, as a rule, not because he had made a special study of hospital construction, but because he would charge less for his services than any one else, or because he had more friends connected with the management than any of his colleagues. He might have specialized in the building of residences, hotels, flats, elevators, saw-mills, or any other structures, and a hospital planned by him would naturally contain some characteristics of such specialty.

There are a few notable exceptions to this rule, however, which have resulted in giving to the construction of hospitals general tendencies, which will be discussed later.

It is of enormous importance to every community contemplating the erection of a hospital that its institution shall supply the following conditions:

It must supply the greatest amount of hospital care of the best quality to the greatest number of patients at the smallest possible expense as regards, (a), the construction of the hospital; (b), the maintenance of the hospital; (3), the expansion of the institution as the demands for hospital beds increases in the community.

The difference in the matter of original cost in the construction of hospitals is so extraordinary that one is able to appreciate it only by carefully comparing individual instances and applying the results to the construction of hospitals in general.

Those best qualified to judge seem to be of the opinion that every civilized community requires one hospital bed for each one hundred inhabitants.

This ratio, if applied to the population of this country, would result in the establishment of nearly one million hospital beds.

Comparing the construction of hospitals the following conditions will be found to exist:

Institutions have been constructed so that in one case the amount expended per patient per bed, may be as high as ten

thousand dollars, while in another institution capable of giving the patient the same degree of safety, and the same quality of hospital care, will have cost not exceeding one thousand dollars per bed. Applying this to the entire number of beds required for the proper hospital provision for this country and the enormous difference in the cost of construction alone is nine billions of dollars—a sum equal to the entire national debt of this country at the present time. Calculating this at an interest rate of four per cent. per annum we find that there would be an annual waste of more than one million dollars per day. The logical conclusion from these figures would necessarily be that such useless extravagance must result in an impossibility to provide a proper number of hospital beds, or as has happened in a number of instances, after the completion of the structure there will be no funds for the maintenance of the institution. The community, in other words, will be in the unfortunate position of the individual who has expended his entire fortune in the construction of a mansion, without making any provision for its support when completed.

Another consideration of the subject would lead us to equally disastrous results. A community requiring one thousand hospital beds would expend the sum of ten million dollars in the construction of the hospital, were this done on the extravagant basis of ten thousand dollars per bed. On the other hand, were the buildings constructed on the economical basis of one thousand dollars per bed the entire sum expended in producing the building, completed for work, would amount to one million dollars, leaving a surplus of nine million dollars for maintenance. Placing this at interest at four per cent. would result in an annual income of three hundred and sixty thousand dollars, a little less than one thousand dollars per day, a sum sufficient to cover the running expenses of such an institution conducted honestly and economically.

There is a fundamental principle involved which makes it possible for such differences as these which have just been described to exist. The principle depends upon the fact that in the construction and management of hospitals at the present time it rarely happens that the persons who furnish the money for the construction and maintenance are at the same time actively employed directly in the work. And it is most natural for any person, no matter how conscientious he may be, to err in the direction of producing an attractive institution, rather than to secure economical construction.

It is quite as important to build an institution with a view to economy in its maintenance after it has been constructed, as it is to secure economy in the construction itself; because there is a

wide difference between the expense of conducting an institution which is conveniently planned and one which is planned without regard to the convenience of its management.

The average cost of maintaining a bed per year is approximately one-third of the cost of construction per bed; consequently the amount expended for the upkeep of a hospital is approximately the same for every three years of its existence as the original cost of the building.

In the management of any other enterprise the tendency of the present time is to house the enterprise in such a mannr that it can be carried on with the greatest possible safety, economy, facility and convenience.

In mercantile business, for instance, the building must furnish an opportunity for accomplishing the greatest possible amount of business at the smallest possible expense. It must be convenient for those who conduct the enterprise, and attractive to those whose patronage is sought.

In office buildings the tenant should have convenient quarters for his work, combined with attractiveness to his clients, without occupying relatively too great an amount of space for his especial business.

In manufacturing enterprises the same principle is applied, and so on throughout the entire list of buildings. In each instance the person for whom the structure is erected furnishes the means, either in capital or in rentals, with which the plant is constructed. It is necessary for his continued existence in business that the building corresponds to the requirements in the case. Unless this is accomplished his business will suffer in competition with his neighbors; and if his working plant is entirely inadequate this fact alone will result in his bankruptcy. In other words, the natural elements of competition enter into the *organization*, *construction* and *management* of all of these enterprises.

It is a well known fact that no amount of capital could be safely invested in any business enterprise to-day in competition with other similar enterprises unless it were established, built up and conducted by those familiar with the particular kind of work.

Every one knows of prosperous undertakings that have been built up under the leadership of a person understanding his business, and which have gone to ruin at the death of this person, when his heirs, who were not familiar with the enterprise, have assumed its care.

This principle is constantly observed in the organization, construction and management of hospitals, and were it not for the willingness of philanthropic persons to foolishly place their wealth

in the hands of such incompetents, these institutions must necessarily go on to bankruptcy, precisely as is the case in the dissolutions of private fortunes with which all are familiar.

With the introduction of competition in the conduct of hospitals this element must of necessity be applied in the organization, construction and management of hospitals that hope to continue for any considerable period of time.

The important position that hospitals have taken during the past few years has made it worth while for capable persons to make hospital management their life-work; and this must in time result in placing their management on the same bases with all other important affairs. It is therefore becoming worth while to study the subject of hospital organization, construction and management in a systematic manner.

CHAPTER I.

HISTORICAL.

The word hospital has its derivation in the Latin *hospitalis* (adj.) and from the noun *hospes,* a host or guest. The place in which a guest was received was in Latin *hospitum,* from which was derived the French hospice. In time the adjective became used as a noun and the words *hospitalis, hospitale,* now hopital and hospitalia, were adopted. The English word *hospital* comes from the old French *hospitale,* as do the words *hostel* and *hotel,* all originally derived from the Latin. The three words *hospital, hospice* and *hotel,* although from the same source, are used in different meanings. The first, *hospital,* usually means establishments for temporary occupation by the sick and injured; the second, *hospice,* a place for permanent occupation by the poor, the infirm, the incurable or the insane; and the last, *hotel,* dwellings either public or private, for ordinary occupation.

Canon Farrar, in his "Life of Christ," says, "Amidst all the boasted civilization of antiquity there existed no hospitals, no asylums, no penitentiaries." However well this statement may apply to penitentiaries, it can scarcely be true of hospitals and asylums. One need only read pre-christian history concerning hospitals and dispensaries, to find authentic and interesting information regarding the curing of the sick, the instruments and medicines used, and the places provided for housing them in sickness. If these houses or refuges were not called hospitals, it is only because the word as applied to its present meaning was not then in use. Certainly the work organized and the work accomplished in those days was worthy the respect and consideration of scientists even in this over-scientific, overworked twentieth century.

There has been, and there is now, much discussion and inquiry as to the origin of hospitals, Jews and Christians alike contending for the honor of having first given them to mankind. For the word only should they be given priority; in worthy deeds the work had long been accomplished before them by the Romans and the Hindus.

Hospitals are simply the development of the dispensary used in ancient times by medical officers appointed and paid by the

state. This room or dispensary was used by the medical officers in which to see their patients and dispense their drugs. This eventually developed into the hospital ward, where patients could be more carefully attended, and be under observation by the medical officers. "It is therefore in the medical officer, appointed and paid by the state, that we find the earliest germ and first idea of the vast network of hospitals which have spread over the civilized countries of the world."

In the eleventh century B. C. there was a college of physicians in Egypt, who received public pay, and were ruled by law as to the extent and nature of their practice. At Athens in the fifth and sixth centuries B. C. there existed physicians and dispensaries; mention is also made of one hospital. The physicians were elected and paid by the citizens.

In the fourth century B. C. an edict in India by King Asoka commanded the establishment of hospitals throughout his dominions, and there is direct proof that these hospitals were in existence and flourishing in the seventh century A. D. We read in Homer of army surgeons, consequently they are of remote antiquity. The first military hospital of which we have any definite record was established during the reign of Hadrian, in Rome, 117-138 A. D. The ancient Mexicans had hospitals for their wounded and disabled soldiers, and for the care of the sick of all classes. Asylums for the insane were first discovered among the Mohammedans.

That the "medical administration" was made to include both man and beast is a direct indication of the wisdom of the government in caring for its subjects. We quote from the edicts of the establishment of a system during the time of Alexander the Great, 300 B. C: "That wells and trees and caravanseries were to be erected in the public highways for the use of travelers; and that the sick and wounded were to be carefully attended to by the erection of medical houses or hospitals, and depots of medicine for the sick of man and animals." (*History of Medicine*, 1857.)

These are the first hospitals of which we find any distinct record. They were provided with instruments and medicines of all kinds made from mineral and vegetable or herb drugs. "And skillful physicians were appointed to administer them at the expense of the state." It is also stated that the sick were provided with food "according to their experience of what is right." From these significant details we may conclude that medical knowledge among the ancient Asiatics was based upon humane and practical principles, with no element of superstition, hypnotism and fraud that came later in connection with this work.

Evidence is conflicting concerning the reign and the death of Gautama Buddha, but it can be safely estimated that both of these events occurred as early as the fourth century B. C. We find record of his having appointed physicians, "one for every ten villages"; and he also built asylums for the sick, the destitute, and for the cripples. His son Upatisso built hospitals for the blind and for pregnant women. Just here it seems fitting, in further proof of the pre-christian origin of hospitals, to quote from the *Westminster Review*, 1877.

"Thus we see that the glory of Christianity does not lie in having originated the idea of hospitals, but in having seized it like the runners the torch in the ancient games, and carried it forward with brighter flame and more intense enthusiasm. The fame of Fabiola and St. Basil has been immortalized by St. Jerome and the Gregorys; the edict of Asoka is graven with a pen of iron in the rock and a living witness to the noble thoughts of his kingly mind; the "House of Sorrow," which was built within the ancient *rath* that exists to this day, speaks of the tenderness of the Princess Macha; but no trace remains of the names and titles of the men and women who built the solitary hospital on the seashore in the Poraes, who founded the house of separation for the lepers in Judea, and the home for disabled soldiers in Mexico, or of those more illustrious who, in ancient Egypt, conceived the idea of the physicians paid by the state to tend the poor. Their names may be forgotten, but their deeds are immortal; they have joined

"That choir invisible
Whose music is the gladness of the world."

After the introduction of Christianity we have reference, first, to the "Pool of Bethesda," 31 A. D., where shelters were erected for the sick and the cripples who came to drink the water which was said to possess miraculous healing powers.

In the years 370-80 A. D., Valens, in Cæsarea, Fabiola, in Rome, built hospitals and almshouses for the sick and destitute. After this came the *infirmaria* of the monasteries. In the course of time these infirmaries developed into separate buildings, with special appropriations for their maintenance.

In the ninth century, at Sienna, the Knights of St. John, of Jerusalem, built hospitals for pilgrims and attended them when they were sick.

About the year 1530 Johnde Dios, a Portuguese, of the order of the "Brother Hospitallers," converted his home, a deserted shed, into a hospital; and in time he came in possession of a large building, where he and many other pious men cared for the sick

and unfortunate. In this way the first hospital of the Order of Charity was founded.

It will be interesting to quote here from the *Encyclopedia Britannica*, 1881: "About the earliest distinct record of the building of a hospital in England is in the life of Laufrance, archbishop of Canterbury, who, in 1080, founded two, one for leprosy and one for ordinary diseases. The former is referred to in the *Vie de St. Thomas le Martyr,* a work of the twelfth century. The establishments for the sick remained in the hands of the clergy until the Reformation, when some of the monasteries and church properties were appropriated and set apart for the use of the sick. Of these the most noted instances were St. Bartholomew's, at Smithfield, St. Thomas' in the Borough, Bethlehem or Bedlam, Bridewell, and Christ's Hospital, which were long known as the 'Five Royal Hospitals.'"

From this time until the beginning of the eighteenth century the information and records concerning hospital building is of a nature too vague to be interesting. It was in the eighteenth century that the "great movement" in hospital building took place. The following table from Dr. Steels' paper "*On the Mortality of Hospitals*" (*Encyclopedia Britannica,* 1881) gives a list of the chief institutions founded during that period in England.

London.	Date of foundation.	*Provincial.*	Date of foundation.	*Irish.*	Date of foundation.
Westminster	1719	York	1710	Dublin.	
Guy's	1723	Salisbury	1716	Jervis St.	1726
St. George's	1733	Cambridge	1719	Steevens's	1733
London	1740	Bristol	1735	Mercer's	1734
Middlesex	1745	Edinburgh	1736	Meath	1756
Special Hospitals.		Windsor	1736	House of Industry	1774
The British Lying-in Hospt.	1749	Aberdeen	1739	Special (Dublin).	
City of London Lying-in	1750	Northampton	1743	The Rotunda Lying-in	1745
Queen Charl'te's Lying-in	1752	Exeter	1745	The Lock	1754
Smallpox	1746	Worcester	1745	The Westmoreland Lock	1755
Lock, female	1745	Newcastle	1751	Cork	1720
Lock, male	1747	Manchester	1753	Limerick	1759
		Chester	1755	Belfast	1797
		Leeds	1767		
		Stafford	1769		
		Oxford	1770		
		Leicester	1771		
		Norwich	1771		
		Dumfries	1775		
		Hereford	1776		
		Birmingham	1778		
		Montrose	1780		

Provincial.	Date of foundation.
Nottingham	1782
Canterbury	1793
Glasgow	1794
Dundee	1795
Stafford	1797

According to Guttstart the increase of hospitals in Germany from 1876 to 1900 were 3,300 in number, and according to the Medical Commission of Germany there were 3,000 hospitals with 140,000 beds, and in 1900 there were 6,300 hospitals with 370,000 beds, an increase of 250 per cent in the number of beds in a quarter of a century. In Prussia alone statistics show that from 1,502 hospitals with a total of 75,000 beds in 1876, there was a total of 2,040 hospitals with 110,000 beds in 1885, and the enormous total of 3,900 hospitals with 214,000 beds in 1900. In less than twenty-five years in this small state alone, the number of beds had been tripled.

In this country, also, great attention is paid to the subject of hospitals and hospital building. The increasing interest, and the increasing demand, has influenced thoughtful, skillful men to make the study of hospital construction a life work, and in consequence the present century must undoubtedly mark a new era in all matters pertaining to the organization, construction and management of hospitals. The same vast changes that have been wrought in other industries must come into this field as well, and the last quarter of the last century has introduced many new conditions and elements. The most important changes indicated are due to our knowledge of the life history of various pathogenic bacteria, and an appreciation of the manner of their transmission from one person to another. For many centuries it has been known that contagion, infection and inoculation were conditions that must be considered in connection with hospital care of patients, but the actual manner in which these conditions were accomplished were unknown until the work of Louis Pasteur made it possible for Joseph Lister to apply the principle of infection directly to surgery, and this in turn opened the field to other scientists until the entire subject has become a part of the education of all who are interested in hospital work. This principle of infection has influenced the construction, and given rise to the consideration of hygienic principles in all inhabited buildings, but more particularly in hospital buildings. The influence of dampness, dust and absence of sunlight has become an important factor

to be studied in connection with hospitals. In the old records we find many traces to indicate that these facts were understood and appreciated thousands of years ago, and it is interesting to speculate as to whether these facts were based upon scientific principles as applied to things in ancient times, or whether these really simple truths were observed as a matter of self-protection, or of instinct.

There are many factors to influence the growth of hospitals and make concentration a natural result.

The growth of enormous cities has produced conditions which demand public and semi-public care for a great portion of the population.

The element of safe, cheap and rapid transportation of patients by railroad train, electric street railways, modern ambulances, and later, perhaps, the automobile ambulance, will further influence this field.

The possibility of constructing many-storied buildings safely at a relatively small cost, with perfect protection against fire, has its effect.

The introduction of hygienic plumbing is of great importance.

The use of the elevator and the dumb waiter added another feature to the construction, especially in large cities.

The introduction of the trained nurse has affected every phase of hospital organization, construction and management.

The element of competition, perhaps more than any other factor, is influencing the growth and the construction of hospitals.

The development of preventive medicine and the changes which are in progress in the sociological conditions in this country must add further features to the future history of matters pertaining to hospitals.

All of these elements have been gaining in importance from year to year, and they are also becoming more definite in their influence.

As stated elsewhere, the prevailing idea is that there should be one hospital bed for every hundred inhabitants in this country. It is easy to calculate from this that the subject of hospital building has passed from the stage of a necessary evil, through the experimental stage, until we now must strive to have the best facilities in all respects in these buildings.

Accepting, then, the evidence of the growth and development of hospitals, and appreciating the necessity for their existence, there remains the question of the kinds of hospitals that should be constructed and approved of.

It is acknowledged that there is an absolute demand for hos-

pitals in case of epidemics, in order to keep the afflicted separate from those not so unfortunate; in many instances these hospitals have apparently been the means of arresting the spread of disease, and thus preventing extensive epidemics.

There are *general hospitals* to which cases of all kinds are admitted, while in others certain classes of patients are excluded.

Under the head *special hospitals* are classed:

Hospitals for the insane.

Hospitals for neurasthenics.

Hospitals for contagious diseases.

Hospitals for tuberculosis.

Hospitals for epidemics.

Hospitals for obstetrical patients.

Hospitals for surgical patients.

Hospitals for children's diseases.

Military hospitals.

Naval hospitals.

While Naval and Military hospitals are classed under the head of special hospitals, they are, as regards management at least, distinctly different from the others. The following extract from *Encyclopedia Britannica*, 1890, gives a brief outline of these hospitals past and present:

"These are provided in all civilized countries for the care of sailors and soldiers of state. The two great English hospitals of Greenwich and Chelsea were founded as asylums for disabled and superannuated sailors and soldiers, but the former is given up for that purpose, although a part is appropriated as a hospital for sick merchant seamen of all nations. The chief naval hospitals are those of Hasler, Chatham, and Plymouth. Hasler is the largest hospital in the country, having been originally intended for 2,000 sick, and even now, with increased allowance of space per bed, accommodating 1,500 patients. There are also hospitals in most of the principal naval stations abroad, such as Malta, Jamaica, Halifax, Hongkong, etc. The principal military hospitals are the Royal Victoria Hospital at Netly (the invaliding hospital of the army and the locality of the army medical school), the Herbert Hospital at Woolwich, the Cambridge Hospital at Aldershott and numerous others at the principal stations. The cubic space allotted by regulation is 1,200 cubic feet at home and 1,500 to 2,000 cubic feet in the tropics, per bed. Formerly every regiment of cavalry and infantry, and each battery or troop of artillery, had its own hospital, but this plan is now given up, and station hospitals with a fixed staff are being arranged at the chief centers of military districts. In both the army and the navy the regulations

place the administration and command of hospitals in the hands of the respective medical departments; in the army this as yet is only partially carried out, but it has been accomplished in the navy with the advantage of both efficiency and economy. In time of war general hospitals are established at the base of operations, whilst field hospitals move with the troops as the campaign progresses."

"In France there have long been hospitals established for the navy, such as those at Rochefort, Toulon, Brest, etc., as well as schools of instruction for medical officers. The chief military hospital is at the Val de Grace at Paris, formerly a convent; it is there that the medical school for the army is located. Large hospitals are also established in all the great stations. Great attention to military hospitals is also paid in Germany, Austria and other countries of Europe. In most of them the administration is in the hands of the medical department, except in France, where the intendence still holds the reins, much to the disadvantage of efficiency and good working."

"In the United States of America the army is small and chiefly employed on frontier duties, so that the hospitals are all what are called post hospitals, and as a rule are wooden huts or temporary structures, built to last ten years, and to hold 12 to 14 beds. There are, however, two permanent hospitals, one for cadets at West Point, and the other, the Barnes Hospital, at the Soldiers' Home near Washington. All the arrangements are under the army medical department. The navy and mercantile marine were long amalgamated in America, so far as hospital arrangements went. The Marine Hospital Service was formed in 1798, and the navy was not separated from it until 1811, although it was not for some years after that special naval hospitals were built. In connection with marine hospital service, hospitals have been established at a great number of ports, both sea, river and lake. Up to 1870 each of these hospitals had its own organization, but since that time a regular service has been established under a supervising surgeon-general. A tax of 40 cents a month is levied for the service upon all seamen or members whatsoever of a ship's company. One of the finest hospitals is the Mercantile Marine Hospital at Chicago, a pavilion building of several stories, and of considerable architectural pretentions. But in America, as in Europe, the tendency has latterly been to abandon such monumental hospitals, and to construct single-storied pavilions on the hut or "barrack" principle—the word barrack being employed in this sense as equivalent to the French *baraque*, a wooden hut. Accordingly the new marine hospital at San Francisco has been thus constructed, three

one-storied pavilions of California redwood radiating from the outside of a curved corridor, from the ends and inner center of which project the administrative blocks. The cost is about $600 per bed, whereas the average cost of the older ones was fully seven times that amount, with the drawback that in course of time they became extremely unhealthy, and showed all the evils of hospitalism."

A brief notice will be added here of the history of hospitals, particularly with reference to the pavilion system:

"It is in France that we must look for the commencement of that system, although it has been carried out with even greater success in other countries. Its origin may be traced to the discussions which arose from time to time as to the advisability of reconstructing the Hotel-Dieu at Paris. So long ago as the seventeenth century Desgodets, architect to Louis XIV., presented a plan for reconstructing the hospital in 'rayons.' But it was after the fire that took place in 1772 that question was taken up with real interest. In 1773 it was proposed to transfer the hospital to the plain of Grenelle, and in 1774 M. Petit proposed a radiating building of four stories at the base of the hill of Belleville (probably at no great distance from the existing hospital of Menilmonant). M. le Roi presented a plan for a hospital at Chaillot, consisting of long, single-storied pavilions, arranged alternately, with the roof open at intervals, each patient to be screened off by partitions. Finally the committee of the Academie des Sciences reported favorably in 1788 on a proposal of M. Poyet's to construct a hospital on the Ile des Cygnes (between Grenelle and Passy), consisting of isolated pavilions radiating from a central rotunda, the hospital to hold 5,000 patients, each pavilion to be 110 feet long, by 24 feet broad and 14 to 15 feet high, to contain 34 to 36 patients, and to have windows to the ceiling. These proportions would give 77 to 80 square feet of floor space, to 6½ to 6¾ feet wall space, and 1,080 to 1,200 cubic feet of total space, an immense advance upon then existing arrangements. The Revolution put a stop to those projects, and half a century elapsed before a pavilion building, as now understood, was actually constructed. Curiously enough, revolution again stepped in to arrest the movement, for the first building of the kind, the Hopital Louis-Philippe, was begun in the last years of that monarch's reign, and suspended in consequence of the revolution of February, 1848. Some years later it was completed and renamed Lariboisiere, from the name of the benefactress whose munificence helped to bring it to a successful conclusion."

"The new hospital at Menilmontant, in the northeast of Paris,

is also a pavilion one, differing somewhat in detail, but of great size, each pavilion having numerous stories. The military hospital Vincennes is a good specimen of modern construction. A small experimental pavilion built on the suggestions of Dr. Tarnier in the garden of Maternite in Paris, merits notice. It consists of two stories, each containing four wards, these wards being each for one parturient woman. The kitchen, office, etc., are in the center, but the only access to these wards is by the verandah direct from the open air. The walls, floor and ceilings are non-absorbent, and there is a space of 56 cubic meters, or nearly 2,000 cubic feet, for each inmate."

"The plans of M. Tollet ought not to be passed unnoticed. In addition to the ordinary principles of pavilion construction, he insists upon the ogival or Gothic form of architecture, which he thinks was adopted in the Middle Ages, as much for sanitary as for architectural reasons."

The first pavilion hospital in England was the Blackbourn Infirmary, built rather more than twenty years ago. The pavilions there are at right angles to the center corridor, and are alternate; a similar arrangement is followed out at the Children's Hospital at Pendlebury, near Manchester. St. Thomas' at Westminster Bridge consists of a row of parallel pavilions united by a corridor at one end. A plan practically identical was proposed for a new hospital at Valetta (Malta), but this building, though frequently referred to in books, has never been constructed. The Herbert hospital at Woolwich consists of parallel pavilions jutting out from the sides of a center corridor at right angles; although it is now nearly twenty years old, it is still one of the best examples of a pavilion hospital. The latest pavilion hospital is the New Royal Infirmary at Edinburgh.

In Germany the Friedrichsheim Hospital at Berlin is one of the best specimens of a pavilion building. The pavilions are 160 feet apart, six two storied, and four one storied, with isolation wards and the necessary administration buildings. The hut hospital erected during the late war at Tempelhof, near the same city, was a good example of how the pavilion system may be indefinitely extended, the huts being placed in echelon in wide zigzag lines."

"The earliest American hospital of any size was the Pennsylvania Hospital of Philadelphia, which was begun in 1755, under the auspices of Dr. Thomas Bond and Benjamin Franklin, and finished in 1805. It was also in Philadelphia that the first pavilion hospital of a permanent character was erected, the corner stone being laid in 1860; in it the pavilions are parallel, two stories, besides the basement and attics. The space allowed is ample, but the

wards are too wide, nearly 31 feet. In New York there is a large amount of hospital accommodation—about 6,000 beds, or about 1 in 1,500 of the population. The New York Hospital new pavilion gives 112 square feet of floor space and 1,800 cubic feet of total space. The Roosevelt Hospital has somewhat the same dimensions, but with a much greater space for surgical patients. One peculiarity of arrangement in that building is that the closets are not at the ends of the wards as usual, but in the center, grouped around a central shaft which extends through all the stories, cellar and basement. In this the water and steam pipes are placed, as also the foul linen shafts; the closets are cleaned by a steam jet. This plan does not seem very commendable.

The Massachusetts General Hospital at Boston is the oldest in America, except the Pennsylvania Hospital. Since 1872 four new pavilions have been built on peculiar plans: two are square, one containing one large ward for twenty patients, and the other divided into small rooms of two beds each, giving each about 97 feet of floor space, and 1,500 to 1,850 feet of total space; the other two are oblong, divided into rows of single rooms, with a dividing corridor, something like an arrangement of prison cells. The floor space is about the same, with less height.

The Johns Hopkins Hospital at Baltimore will be memorable for the care bestowed upon the consideration of its plans. The one finally adopted is on the pavilion principle, scattered over a wide space of ground."

This brings us to a new era in hospital construction in this country. This era began with that notable collection of essays on hospital construction published in 1875 ("*Hospital Construction and Organization,*" "*The Johns Hopkins Hospital*"). During the last quarter of the last century this work was used universally as a guide by all architects in this country, as well as by all Boards of Trustees who were painstaking enough to personally study the subject of hospital construction and organization. In England and on the continent one finds frequent references in the hospital literature to this excellent work, which considered the subject broadly and completely, from the standpoint of conditions prevailing at that time.

In Europe, the Berlin Hospital at Friedrichsheim has been mentioned before as an example of this pavilion form of construction. The Hamburg Hospital at Eppendorf is probably the most perfect sample of this system on the continent. For practical purposes we may refer to these hospitals as the models after which most hospitals of the latter part of the past century were planned.

The idea of the cottage hospital was, however, carried out in

detail just one hundred and fifty years ago by an English engineer by the name of Rovehead, who planned a complete cottage hospital at Stone House, near Portsmouth, England, for the care of seamen. This plan was so complete that there is scarcely a hospital built to-day on the cottage plan which can compare in the detail of the idea with this hospital.

A review of the excellent work of Sir Henry C. Burdett, "*Hospitals and Asylums of the World*," 1893, gives the plans of all the important hospitals which were constructed before the close of its publication, and virtually all of these contain the same essentials in their construction. When we bear in mind that during the past thirty years everything in our theories concerning infection, contagion and hygiene has changed, and that scientifically proven facts have taken the place of theories, would it not seem strange should we still adhere to the same essentials in hospital construction? Since the beginning of the present century it has become more and more apparent that the principles laid down in "*The Johns Hopkins Hospital*," 1875, can no longer be used as a basis for hospital construction at the present time. As a result of the changes there is a strong tendency toward the construction of compact, many-storied buildings, especially in the larger cities of this country.

Thus the history of our subject teaches that civilization has experienced changes in this field as in every other form of development. We find a faint tradition of a high form of development in what may be called the pre-historic time; then we enter the dark ages with all their superstitions and misconceptions; then came the slow but constant development which resulted in the recognition of fundamental principles of hygiene upon which at the present time are based our ideals in *Hospital Construction*. With all possible modern facilities as regards location, ventilating, heating, lighting and plumbing, the sick can be placed under hygienic conditions which correspond to those to be desired by persons in health.

CHAPTER II.

ORGANIZATION OF HOSPITALS.

The organization of hospitals must necessarily vary with the conditions under which the institutions are to exist.

The first step must be the formation of a board of directors, governors, or trustees. no matter whether the institution be under the control of a political organization like the State, County or the City, or whether it be controlled by a Philanthropic Society, Church Organization, Medical School, Corporation of Physicians, or by Private Corporations such as Transportation Companies, Manufacturing Companies, Mining Enterprises, or by a Fraternal Organization of Wage Earners.

We shall consider each one of the various forms of control separately, and shall give that form which at the present moment seems to contain the greatest number of virtues, and the smallest number of defects. It is not unlikely that future experience will show in many instances that many forms of control now in vogue in a given class of hospitals must be superseded by entirely new methods, because with the development of institutions, conditions must change in this as in every other human endeavor.

The object in the present effort is to give that which experience has shown to be the best organization up to the present time.

HOSPITALS CONTROLLED BY POLITICAL BODIES, SUCH AS BOARDS OF TRUSTEES, UNDER STATE, COUNTY, OR CITY GOVERNMENT.

These institutions are usually developed for the purpose of providing for the poor who can be treated more perfectly, and with greater economy, than if each patient were cared for as an individual charity.

In most communities there are such institutions also provided for the treatment of special diseases, like insanity, epilepsy and imbecility. In the organization of such hospitals a fairly definite system has been established, the usefulness of which depends entirely upon the honesty of purpose of the political organization in power.

In the organization of the governing body of these institu-

tions, the same as in the other forms mentioned, there are certain qualities required. The trustees must have experience in this field. If they are appointed because of their experience, and because they have worked, faithfully, intelligently, and honestly in hospital work for years; if they have studied institutional work carefully, and if their other duties in life are such that they can give attention to this specialty, then, with their position as trustees relatively permanent, it is reasonable to look for a satisfactory result.

If on the other hand, these trustees are selected by political powers in control, as a remuneration for some political services rendered the party, no care being taken to select men well qualified to fill the position, then the organization must necessarily be exceedingly bad.

To make matters worse, such boards of trustees appointed as a result of what is usually termed the "spoils system" in politics can maintain their position only so long as the political party remains in power and there must of necessity therefore be frequent changes in the membership of such boards.

If the same system is applied also to the officers of the institution, to the nurses and servants, in other words, if there is no plan of civil service employed in any part of the hospital, then the organization can be said to be as bad as possible.

It has been demonstrated, however, that by the introduction of civil service in hospitals under political control, the organization can be made very nearly perfect provided the trustees are selected because of their qualifications, and according to a system which prevents frequent changes.

NUMBER OF TRUSTEES.

It is important that the number of trustees be relatively small because this will enable the community to employ capable people, to give them a reasonable compensation for their services, and require of them a sufficient amount of time to correspond with the requirements of the institution under control.

In some States these trustees compose the Board of Control which manages all of the public institutions: prisons, insane asylums, hospitals, State orphanages, institutions for the blind, for the deaf and dumb, for imbeciles, and for epileptics.

A few of these Boards are composed of men of very great learning, splendid practical ability and undoubted morals, who have made institutional work a life study, precisely as one would make educational or professional work a life duty. In such instances the results have been amazingly good.

The number of trustees should not be less than three, nor more than fifteen. The plan which has been followed in many hospitals, of having a very large Board of Trustees with the hope of being able to enlist in this manner the interest of a large number of persons, who would themselves contribute freely to the support of the institution, and who would at the same time secure support from other persons, has failed to bring the highest satisfaction. In so large a Board, there is never enough for each individual to do to keep him permanently interested, and where so many persons have to be consulted in the matter of management, progress is almost impossible.

When one remembers that most of the business enterprises, such as commercial undertakings, manufacturing concerns, railroads or banks, have a relatively small number of Directors, it becomes plain that, in order to succeed and prosper, a hospital should also have a relatively small number of Directors.

In public institutions under political patronage it would hardly be safe to have less than three or, better, five Directors, because of the danger of forming combinations for personal gain.

Taking three as the number to be appointed in a State institution by the Governor, in a city institution by the Mayor, or in a county institution, preferably by the Judge of the Probate Court, it is wise to have one member appointed so as to retire at the end of each three years, so that the term of office of one will be for nine years. Of the original Board to be appointed, one would serve for three years, one for six, and the third for nine years. In case the number were five, then one should be appointed every second year, making the term of service ten years. In case the number be greater than seven it is probably best to appoint one each year, making the term of service equal in years to the number of Directors.

In some institutions a further precaution has been taken by making it necessary for the Board to contain members from different political parties. In case the Board consists of five members, not more than three may be appointed from the political party in power. In case it consists of seven members, not more than four, and so on throughout the series of numbers. There is a distinct advantage in this because in case of a change in political power the new executive may fill the next vacancy from his own party, and in case of a vacancy from other causes the composition of the Board will not be seriously disturbed by the change in administration, and there will exist no temptation to the new appointive power to force resignation by unfair means, in order

that he may introduce members of his own political party, for his own political reasons, because he would be compelled to again appoint members of the opposing party to replace those whose resignation he had forced.

The permanency of the office will give these Trustees a sufficient security so that they can plan improvements in the service for several years in advance.

Many of the men in this service have made a careful study of their subject, and of the institutions in other States. As a result of this system the institutions in such communities are conducted with great economy and efficiency. The staffs of these hospitals, the employes, the training school for nurses, are all splendidly organized. The supplies are remarkable for their excellence, at the same time they are bought at a reasonable price, and the amount of waste is reduced to a minimum, both as regards work and material.

Such a Board is able to select its employes for permanent service because of their ability to do the particular work entrusted to them in the best possible manner.

So far as known the employes in these institutions have a permanent service for a period of four years, during this time they can be removed only for bad behavior, or neglect of duty. At the end of this time their service terminates unless they are reappointed. This provision seems to be a wise one, because it implies the necessity of continued efficiency. A person does not maintain his position simply because he has secured it and because he does nothing bad enough to warrant his removal, but he must perform his duties sufficiently well to make him more desirable to the institution than his competitor who has filled all the requirements by passing examinations establishing his practical qualifications and by which he is on the available list for the particular work performed by the employe in question.

There is a feature in this system for the appointment of a Board of Trustees which must not be overlooked. The advantage to the person who has the power of appointing—the Governor, Mayor or Judge of Probate Court—cannot possibly be great if he makes the appointment from selfish motives, because he can never hope during his official existence to obtain actual control of the Board so that he could utilize it for his personal advantage, even if he were so inclined. A bad appointment would cause so much opposition from so many sides, that the slight amount of personal gain would not count in comparison with the loss in popularity; and this fact makes the appointment of Trustees more likely to result in a competent Board than the plan of popular

election. (This of course is not the case where the entire Board is appointed by the official in charge at a given time.)

If with the election of every Governor, or Mayor, or Judge of Probate Court, or President of County Commissioners, the entire Board is replaced by a Board appointed by the new incumbent, then this Board may be selected to serve a political "boss," and then the institution must necessarily suffer as a result of this bad system. Some of the worst managed hospitals and asylums in the world are under Trustees appointed in this manner. The extravagance in construction and management in some of these institutions is beyond conception; and the care of patients in institutions whose Trustees are appointed in this manner suffer from all directions because of the fact that the incompetence of the Trustees, added to the selfish motives underlying their existence, is carried through the entire system. The bills paid for construction and for management would purchase the best, but the poorest is delivered; the same is true regarding the bedding and food, and applies to the service, to the personnel of the medical staff, to the capacity of the officers of the institution, to the nurses, and even to the servants, whose number is usually abnormally large in order to provide profitable positions for supporters of the political machine, and their incompetence, indolence, and irresponsibility are correspondingly great.

In the great cities of this country the possibility of the continued existence of a system organized in this manner is easily explained. Those who profit by this vile system are in a position of authority, and so long as the system is to their personal advantage, they are not likely to institute changes. Even men of most excellent qualities, and a high moral standing, will serve in some capacity connected with these institutions, and as a matter of policy those in power usually secure a sufficient number of such men to give the institution a certain semblance of standing.

The two sides that suffer as a result of this procedure are those who pay the taxes, who furnish the funds for the institution, on the one side, and the patients on the other side, who do not receive the care that they would if the money were honestly expended, and who are not in a position to object to such a system.

The tax-payer knows practically nothing concerning the conditions, he is interested in his own affairs, and the patient is glad to get what he can, so long as he gets it free of cost. Patients who would be entitled to the service to be obtained in these public institutions, but who are too intelligent to submit to such abuses, in the large cities receive treatment in other hospitals conducted by Philanthropic Societies or Church Organizations.

It is quite a different matter in the State insane asylums, and State institutions for the education of imbeciles, and for epileptics, because in these all except the very wealthiest members of the population of the State receive treatment.

Fortunately the spoils system is not so common in these institutions as it is in connection with City and County hospitals. This is probably due to the fact that a larger proportion of the intelligent part of the population is directly interested in the individual coming under such care. The matter of extravagance is controlled by the necessity of the Board to make a favorable record. There is a possibility of paying for better supplies than are received, but in these institutions such discrepancies cannot be great.

In studying the conditions in State institutions for the past quarter of a century, one must necessarily have observed an enormous change in the conditions mentioned, and it only remains for the intelligent portion of the population to comprehend the principle involved, both as regards the cost of conduct under the spoils system, as compared with the reasonable system such as has been described, and as regards the natural result of entirely eliminating the possibility of having such institutions conducted under the spoils system.

In the organization then, of State, County or City hospitals of all kinds the following plan seems to be the most reasonable, and the most certain to produce the best possible results.

The Board of Trustees should consist of five members in the primary organization, one of these should be appointed for ten years, the second for eight years, the third for six years, the fourth for four years, the fifth for two years; after that, in case of State institutions, the Governor should appoint one member every second year; in case of a City institution, the Mayor should have this appointing power; in case of the County, it should be left to the Judge of Probate Court, or to the President of the Board of County Commissioners. In each instance it would be well to prevent the appointment of more than three members from the political party of the person in power.

This Board should make a financial report to the Governor, or the Mayor, or the Judge of Probate, or the President of the Board of County Commissioners, accordingly. It should also make, at stated intervals, requisition for the necessary funds for the ensuing year, this requisition to be acted upon by the legislative body of the corporation indicated, whether State, City or County.

The Board of Trustees having been elected the organization

is completed by the election of a President, Vice President, Secretary and Treasurer, and the appointment of a committee of three persons for each important division of the labor involved.

The work can be so divided that each member is the Chairman of one of the important committees, and that two of the other members serve as associates.

The Chairman can thus become thoroughly familiar with his portion of the administration, and every member can be kept posted concerning every detail of the entire work.

The important Committees are on Finance, on Buildings and Grounds, on Supplies, and the Committee on Employes.

From this point on the management must correspond with the management of hospitals organized by non-political bodies, which we shall consider at this point.

ORGANIZATION OF HOSPITALS BY PHILANTHROPIC SOCIETIES.

In cities of moderate size in which the political conditions seem unfavorable for the organization of city hospitals, and in which no particular church seems strong enough to have such an institution of its own, it is often best to organize a philanthropic society for the purpose of establishing a hospital.

This supplies the community with hospital facilities, and at the same time leaves the institution in the hands of the best citizens of the community.

The principal drawback in the fulfillment of such a plan lies in the fact that it requires an entirely new organization for which experience has not as yet granted very satisfactory precedents.

Were it possible to maintain the interest of a large number of these good people, such an institution must necessarily become very prosperous because of the character of its supporters.

When we remember, however, that each one of these supporters considers the institution simply of incidental importance, and that his chief energies are directed toward his own individual enterprises, then it becomes plain why, as a matter of experience, such institutions have not been as prosperous as they deserve to be.

It is in this form that the error of a very large Board of Trustees has usually been made, with the result that none of the members of the Board, with the exception of a few, ever become thoroughly familiar with the work, and that consequently the institution is likely to be left in the hands of those least competent to manage matters of such importance. Frequently the whole conduct of the hospital ultimately falls into the hands of ladies

auxiliary boards, or it is permitted to drift along with practically no management until something happens sufficiently bad to temporarily attract the attention of those whose constant care is needed to build up the institution to a degree of usefulness one could reasonably expect of it.

There is a remedy for this difficulty which has been practised with great success. In every community there are business men of excellent judgment, energy, reliability and experience, who have retired from active commercial pursuits, either entirely or to such an extent as to leave almost their entire time free for rest, or for such things as they can find to do without exposing themselves to any great degree of wear and tear. A Board of Trustees composed of such men, wherever it has been tried, has insured the introduction of tried business principles into the organization and management of hospital institutions.

The character and recognized judgment of these men, serves to assure those who contribute toward the support of the undertaking, that the money is wisely expended, and vouchsafes a degree of stability which can hardly be secured if the institution is in the hands either of impractical philanthropists, or business men who are so completely occupied with other concerns that they can give little or no time, and no continued thought, to the hospital.

The selection of the members of such Boards must depend largely upon the manner in which the organization is constituted. but experience has shown that no matter how the organization is constituted, there are some principles which must be introduced and maintained in order to make the undertaking eminently successful. Of these the most important is the one already mentioned, viz., every member of the Board of Trustees should possess business capacity. This will become more and more necessary in the future because of the natural introduction of the element of competition.

So long as hospitals are few even those managed without business capacity may continue to exist, and even prosper to a certain degree. This however will no longer be possible as soon as there is active competition.

The next quality which each member of the Board of Trustees should possess is an interest in the development of the institution.

Wherever Trustees are chosen because of their prominence, either in business or in social affairs, with the hope that this alone may bring prosperity to the institution, one is certain to find disappointment.

Hospitals cannot grow spontaneously; those intrusted with their conduct must furnish the impetus to their development, precisely the same as though it were in other enterprises. Aside from this it is necessary that the Trustees be willing to contribute a considerable amount of time practically every day to this work. There is an endless amount of labor connected with the various details, which can be left to subordinates in a general way, but the supervision of which must be in the hands of the Trustees, and unless this is done the development will be weak at some point, and progress must necessarily be obstructed.

It is plain that in these institutions, as well as those under political control, it is important that the management should not fall into the hands of dishonest, selfish persons, who use the cloak of charity as a means of advancing their own personal interests.

In this class of institutions this has perhaps happened so rarely as to not merit particular consideration, but with the growth and development of hospitals everywhere conducted by philanthropic societies there is a sufficient possibility of danger from this side to make it important that those interested in such institutions should bear it in mind.

Taking, then, for granted that the Board of Trustees has been selected, composed of not more than fifteen men with acknowledged business capacity, and of high moral standing, with an interest in the development of the institution, and with a willingness to give a considerable amount of time to the work, and an ability to do this without neglecting their other duties in life, the purpose is properly started in its organization.

Were one to apply all of these conditions to any other design, the same number of men, with the same qualifications and interest in the organization and development of that with which they were quite entirely unfamiliar, one would scarcely expect very satisfactory results; and still in every community in which a hospital is originally started, this state of things must necessarily exist.

One would naturally look to the physicians in the community for advice in this relation, because they are directly interested, and because during their studies they have naturally come in contact at least nominally with hospitals connected with medical schools. In due course there will be valuable help in the organization and development from this direction, but in the past most physicians have gone into practice without having had any official connection or training, having simply seen the patients and observed their treatment without the opportunity of learning the minor working of the hospital institutions visited more or less regularly.

At the present time an increasing proportion of young graduates in medicine look forward to the time when they will be officially connected with the staff of some hospital, seeking the position of residents in hospitals directly after graduating; and while in this position they not only perform their duties as assistants, but they also learn all they can concerning the management of the institutions in which they happen to be located. It is from these men that Boards of Trustees will in time learn much concerning hospital management; but it is only from long continued experience that they can hope to attain perfection in this, as in every other sphere of work. This fact in itself makes it of the greatest importance that each member of the Board of Trustees shall have a service sufficiently long to make it worth while to give the time necessary for becoming thoroughly familiar with his duties. This can be best accomplished in the following manner: Take for instance a Board composed of fifteen members. The service of each member composing the original board, should vary from one to fifteen years. Each successive year the place of the member whose term expires should be filled by a new member whose term of service should be fifteen years.

In case the number of Trustees be less than ten and more than five, a new member should be elected every second year. In case the number be five, which is the smallest reasonable number of Trustees for an institution of this kind, the service of the original members should be for periods of three, six, nine, twelve and fifteen years, and after this election, a new member every three years for a period of fifteen years.

There are many other distinct advantages aside from the element of permanency. The system provides that there will always be a large majority of Trustees who have been on duty a sufficient length of time to be familiar with the conduct of the institution, and each new member will have gained much experience before it will be possible for him to introduce foolish and untried methods which are ruinous to the progress and prosperity of any undertaking, and which are more likely to be foisted into the conduct of an institution in which the funds are not supplied directly by the management.

It is natural to hesitate before introducing new, untried methods in the conduct of business enterprises, in which failure would result in considerable personal financial loss. This is not always true, however, in institutions in which there is no possibility of personal loss.

Furthermore, the element of permanency encourages the ambition of actually accomplishing worthy philanthropic ends, in

other words, which makes it worth while to plan relatively great things for the future.

No matter what the number of Trustees may be it is well to have any vacancy which may occur temporarily, filled by the remaining members of the Board, because in this way, all the committees may be kept constantly filled, and it will not be necessary to have special elections at irregular times.

The vacancies from any cause should be filled permanently for the remaining period of service of the Trustees whose vacancy is to be filled at the next regular election.

It is important that these institutions be conducted in a non-personal manner. The service should be according to the most advanced form of civil service method. Too often people who have been unable to earn a livelihood in any other occupation, but who have been able to secure the friendship of some member of the Board of Trustees have been employed. In this way it frequently happens that the work that could be done by one competent person, to the advantage of the institution, is very poorly done by two or three, or more, incompetents.

It is obvious that no business or manufacturing enterprise conducted on this plan, could exist for any great period of time in competition with one properly conducted.

CHURCH HOSPITALS.

What has been said of the organization of hospitals under the control of philanthropic societies can be said with equal truth of institutions under the control of religious denominations. These institutions are, however, possible only in the larger cities, because the membership of any individual denomination in a small town or city is scarcely sufficient to support an independent institution, and the fact of a hospital in these towns being denominational is likely to result in opposition from the various other denominations. Moreover, hospitals in great centers belonging to the various churches usually attract attention and aid from the churches of the same denomination in the smaller communities, and from these churches secure a considerable portion of their membership. For this reason it is probably better to make the hospitals in all the smaller towns entirely non-denominational.

It is well to distribute the members of the Board of Trustees in these denominational institutions among the various churches of the community. If the number of churches does not exceed fifteen it is well to select one member of the Board of Trustees from each church. This may be accomplished by framing the by-laws accordingly. In case the number of churches interested is

less than the number of trustees desired, one trustee may be chosen from each one of the smaller churches, and two or more from each of the larger ones. In case the number of churches greatly exceeds the number of trustees desired, the churches may be grouped, and each group be represented upon the Board by one member. It is best to have a definite system established at the outset, as this will eliminate a great amount of jealousy and trouble later on.

It is well in church hospitals to guard against too large representation of the clergy upon the Board of Trustees, as experience has shown that the qualities which result in distinction in this profession rarely produce men who can wisely conduct important business enterprises; and unless the majority of the trustees of a hospital are competent business men the institution cannot possibly thrive.

The manner of selecting the trustees must be the same in church hospitals as in hospitals under the control of philanthropic societies; the same is also true regarding their term of service.

ELECTION OF TRUSTEES.

The methods in vogue for the election of Hospital Trustees at the present time are so varied that it is difficult to select any one method which is at all satisfactory.

The plan which has probably fewer bad features than any other is what is known as the self-perpetuating method after the election of the first Board of Trustees. The Board itself elects the successors at the stated periods indicated above.

The Board may be limited in its choice to the members of the association or organization which supports the institution, or it may be limited in as many directions as the special conditions under which the institution has been created demand. But the primary principle involved lies in the fact that each succeeding member of the Board of Trustees will be elected by those who have an intimate knowledge of the necessities of the institution because of the experience they have gained during their management thereof. Whatever the tendencies of any individual member might be, the tendency of the Board as a whole, is sure to be for the good of the institution.

Where this method has been tried it has generally been very satisfactory. The only serious difficulty lies in the danger of making use of the patronage of the institution for the purpose of giving employment to relatives and intimate friends. This evil can be eliminated more or less successfully by passing a by-law for the guidance of the Board of Trustees which prevents the employment of relatives in any of the salaried positions. It is true

that this might result in a certain amount of unnecessary hardship to some worthy persons related to some member of the Board of Trustees, but the likelihood of this is so slight that it need not be considered.

The member of such a Board who fails to perform his part of the labors involved in the conduct of the work is not likely to be re-elected by his colleagues because they have had an abundant opportunity to determine his lack of value; a fact of which those outside of the Board of Trustees might be entirely ignorant.

It is however important that if the self-perpetuating system be adopted, the period of service be sufficiently long to make the members of the Board thoroughly familiar with each other's methods during their term of service.

Another method of election which has been more commonly employed, and which with the long term of service has also been satisfactory, is by ballot of the members of the central organization; each member having one vote and the person receiving a plurality being elected for the period of service, or for the time for which the vacancy is to be filled. This method leaves greater opportunity for political manipulations, or intrigue, but if the plan is so arranged that not more than one member of the Board is elected each year, or each second or third year, then the danger from this source is not great.

A third method which seems to be more advantageous consists in the election by ballot by the members of the organization, of the members of the Board of Trustees from a limited number of persons nominated by the existing Board. In this way the persons having the greatest amount of experience can select a limited number of persons, anyone of whom possessing the qualities which seem desirable to those having had the greatest amount of experience. It is clear that in this way the members of the existing Board cannot independently fill the vacancy, and any member of the Board whose term expires must obtain the sanction of the members of the organization in order to be re-elected to his position. In case, however, a new member is elected, he will have to serve a considerable period of time before he can have any harmful degree of influence.

ELECTION BY NUMEROUS ORGANIZATIONS.

Occasionally the organization supporting a hospital is composed of a number of sub-organizations. In case the first plan of election of Trustees is chosen, it may be wise to make it imperative to elect one or more members from each of these sub-organizations.

In case the second method is adopted it may be wise to have

successive members chosen by the various sub-organizations in a different order.

When the third method is selected it may be well to have the existing Board nominate members successively from the various sub-organizations in order to secure a fair distribution among these various bodies.

If the hospital is supported by a stock company the Trustees must of course be elected in the manner by which Trustees of other stock companies are elected. Here again, it is of importance that the same plan heretofore advised be adopted to secure permanency in office.

If the hospital is a public institution supported by the taxation of property owners, then the members of the Board of Trustees should be elected by popular vote, again for a long period of service, or they should be appointed by one of the principal officers.

It really matters little how the selection of the Board of Trustees is made, provided the dangers pointed out are guarded against. In order to make this more emphatic it may be well to recapitulate:

Secure men of integrity and business capacity, who will be interested in the institution, who possess the willingness as well as ability to give time.

The term of office must be a long one in order to secure experience. The plan must provide for conditions which will make the Board as nearly as possible non-personal.

What has been said regarding the selection of the Trustees of hospitals conducted by philanthropic societies is equally true in case the institution is conducted by any church or medical school, corporation of physicians, or by wage-earners' societies, or by private corporations.

When a Board has been established it is important that the entire business be placed and left in the hands of such Board, precisely as in commercial affairs. The stockholders of a corporation place their property completely in the hands of a Board of Directors, and interfere with their action only in case of dishonesty or gross mismanagement.

From the fact that hospitals are philanthropic institutions it frequently happens that this very principle, which is absolutely necessary to secure success in any direction, is overlooked and that every one having the slightest interest in the institution feels called upon to participate in its management. This might seem impertinent if a study of existing conditions did not show this tendency to be entirely reasonable. It is as natural for the interested person who has no official right to interfere with the

management of a hospital to feel moved to take upon himself the privilege or duty of interfering, as it is to reach out for the lines when riding with a careless, inattentive or incompetent driver.

If in business corporations the persons in authority were to apply themselves to their duties with the same degree of attention (or inattention) that is often given by those who have the management of hospitals, the stockholders would soon force the concern into the hands of a receiver. If, however, the Board of Trustees is formed and maintained according to the outlines given above, it is plain that those interested will see that the ones in charge of the institution can, and do, carry on its affairs with so much ability, capacity and attention, that they will be as ready to leave it in the hands of these Trustees as they would be to leave the interests of their business enterprises in the hands of a competent Board of Directors.

CHAPTER III.

OFFICERS AND AUTHORITY.

Having secured the Board of Trustees having all of the desirable qualities, we may give our attention to the matter of management of the institution.

It perhaps may seem needless to say that the management of hospitals must be based upon simple business principles. Yet these institutions, except those known as strictly private hospitals, always contain the element of charity, which should not in any way interfere with the fundamental idea of conducting them strictly according to methods known to be necessary in every business enterprise in order to secure permanency and success.

One of the difficulties that one encounters at the outset lies in the fact that the income of most hospitals is relatively small, and that for this reason it is impossible to secure employes with unusual experience or business capacity. It is consequently necessary to use a system in all of the business affairs of the institution so simple that any intelligent person with a willingness to learn can comprehend and do his share in carrying out the details of such system without much risk of making errors.

As to the matter of experience it can be affirmed that it is not difficult to obtain capable persons for performing all of the duties involved, provided the same methods are employed in their selection that would be employed in any other important work.

If the best person that can be secured is selected for every position in question, consistent with the amount of money available, there need be no difficulty in obtaining satisfactory service. If, however, the institution is made the dumping ground for incompetents who are maintained in their positions without regard to the quality or quantity of service they render, and because of some pressure that is brought to bear in their favor from without, then quite the opposite must be expected.

Good service can best be obtained by following a form of civil service, which selects each person for the position in question because of his special fitness, and places each department under the head of one responsible for this department, and makes it impossible for any one, whatever his position may be, to interfere with

No. 1—*Diagram of Authority for Large Hospital*

Hospital Society or Stockholders.
Board of Directors or Governors or Trustees.

- Secretary.
  - Librarian.
  - Records of board meetings.
  - Records of work done by staff
- President.
  - President of Medical Staff.
    - Superintendent of Nurses
      - Head Nurses.
      - Night super-intendent.
        - Pupil nurses
      - Maids and orderlies.
    - Resident staff including internes and externes.
    - Heads of various medical departments.
      - Members of each department.
      - Assistants of each department.
  - Auxiliary Committees according to requirements. The fewer the better.
    - Endowment.
    - Donations.
    - Entertainments.
    - Library.
    - Linen.
    - Delicacies.
    - Flowers.
  - Superintendent of Hospital.
    - Matron.
      - Chief cook.
      - Head laundress.
      - Head waitress.
        - Assistants according to requirements.
    - Engineer.
      - Fireman.
      - Electrician.
      - Elevator man.
      - House Carpenter.
    - Stenographer.
    - Book-keeper.
- Treasurer.
  - Collections.
  - Auditing Accounts.
  - Disbursements.

No. 2.—*Diagram of Authority for Hospital of Moderate Size.*

Board of Directors.

- Secretary.
  - Records of board.
  - Record of work by staff members.
  - Histories of patients.
- President.
  - President of Medical Staff.
    - Superintendent of Nurses.
      - Head Nurses.
      - Night Super-intendent.
        - Pupil nurses.
      - Maids.
    - Resident staff including internes.
    - Heads of various departments.
      - Members of departments.
      - Assistants of departments.
  - Auxiliary Committee according to requirements. The fewer the better.
    - Endowment.
    - Library.
    - Linen.
    - Delicacies.
    - Flowers.
  - Matron.
    - Engineer.
      - Fireman.
      - Elevator man.
      - Electrician.
      - House Carpenter.
    - Chief cook
      - Assistants according to requirements.
    - Head laundress
      - Assistants according to requirements.
    - Head waitress.
      - Assistants according to requirements.
- Treasurer.
  - Collections.
  - Book-keeping.
  - Disbursements.

any given department except through the head of such department. In order to make this principle clear, the accompanying diagram of authority will be found useful.

For many years the idea seems to have been accepted that philanthropic work can be done by any one without regard to his having been successful in previous undertakings; although his preceding failures, in most instances, must necessarily have been due to unreliability, indolence, indecision, incapacity, lack of judgment and lack of tact; and too often a congenital or acquired form of impudence. This is true to so great an extent that in many philanthropic institutions the moment one enters the place and comes in contact with the various employes, one is impressed with what might be properly called an unwholesome moral and intellectual institutional atmosphere. Every close observer who has visited a large number of hospitals must have encountered this condition many times.

The cause of this lies in the lack of selection. Either the head of the institution, or the heads of some of the important departments, lacks the necessary stamina or judgment, or, they are forced to accept their subordinates not in accordance with their judgment, but because of outside influences. This is especially true in institutions in which a strong pressure is felt from the side of the clergy, and from the side of the ladies' auxiliary boards.

With the introduction of active competition the principle of natural selection must sooner or later eliminate this drawback. In order to exist institutions will be compelled to place at the heads of the various departments persons who have the necessary force of character and judgment to appreciate the fact that success must depend upon the elimination of this evil.

Having secured properly qualified heads for the various departments, it is important to have the organization so complete that there can be no doubt concerning the lines of authority. The accompanying diagrams, which must of course be elaborated to suit the conditions of any given case, plainly show the various lines of authority.

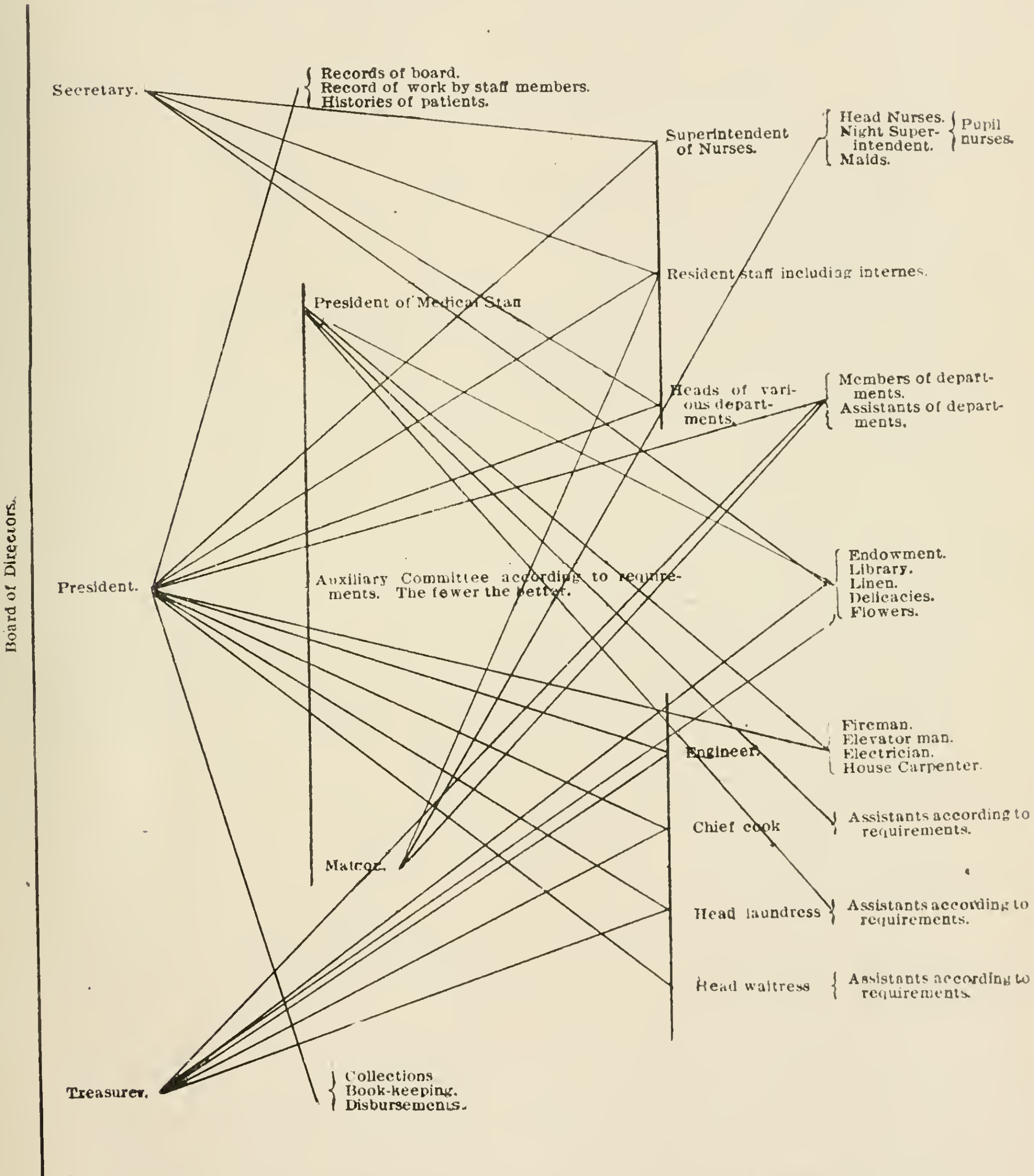
Each person in this arrangement is responsible to but one. He goes to but one for his orders and for his advice. In case his superior is incompetent from some cause, any dispute can be carried to the person above, and so on to the President of the Board of Trustees, and by him to the Board of Trustees.

This system also outlines a definite channel through which the various heads of departments come in contact.

In preparing a diagram of authority the name of each official and employe should be placed underneath the office occupied by

this position, so that the employe himself will know, by referring to the diagram, the direction of the lines of authority.

In table Number 3 is an illustration of the result in case the lines of authority are not adhered to. This table would fairly



represent the result in some of the worst managed institutions of this kind.

Of course, it is impossible in an illustration of this kind to place a sufficient number of lines to indicate all of the possible conditions of confusion which are likely to occur. All of this confusion

can, however, be easily avoided if each person in authority closely adheres to the lines. Supposing a member of one of the auxiliary committees finds some part relating to the diet of the patients unsatisfactory. Instead of upsetting the mechanism of the institution by interfering with the kitchen department, he should make a note of the condition referred to, should consider it carefully, and should place his ideas before the President of the Board of Trustees. That official, in case the difficulty lies with the preparation of the food, will refer the matter to the superintendent of the hospital, who in turn will discuss it with the matron, who in turn will interview the chief cook, and he will either explain the present difficulty satisfactorily, or refer it.

Should the complaint lie in the serving of the meals, which is directly under the superintendent of nurses, then the inquiry would pass from the President of the Board to the president of the medical staff, and through him to the superintendent of nurses, and through her to the head nurse of the department in which the difficulty occurred.

Should the difficulty imply a faulty system in both of these departments, then a conference may be held between the matron and the superintendent of nurses. The initiative coming from the President of the Board, through the president of the medical department to the superintendent of nurses, and if the matter is of great importance, then it should be referred by the President of the Board to the committee on housekeeping, and this committee should discuss it with the various heads of the departments involved.

It might seem as though this plan would involve an endless amount of red tape, but as a matter of fact it is the most direct way of correcting faulty methods.

In case the matter is of only slight importance, then another plan should be followed, which, if invariably employed by each one of the various heads and sub-heads, must ultimately result in a very perfect system.

If any person of authority in any department encounters some feature which appears to be harmful to the institution, but which is not of sufficient importance to be referred to the head of the department, the proper manner in which to secure the correction is by asking for information; if the subordinate whose act is in question has a valid reason for this act, then the person who has made the observation will appreciate such point and will be satisfied with the method employed. If there is no reason for doing the particular thing in a faulty way, then further questioning may bring out a better method.

The danger to the discipline of the institution from the use of this method would appear to lie in the fact that a sensitive employe might look upon the inquiry as a criticism or an interference outside of the province of the person making the inquiry; but with the acquisition of competent employes this system works admirably.

ADHERENCE TO DEFINITE SYSTEM.

Few heads of departments appreciate the great value in developing a plan according to which certain things can always be done in the same manner. There is, of course, danger of establishing a form of routine which lacks energy and individuality, and which in time must fall behind in active competition. This error must, of course, be guarded against if one hopes to accomplish the highest character of development of an institution.

On the other hand, no one ever does any one thing well unless he has had an opportunity to do it many times, and if the system is changed constantly, everything must of necessity always be done poorly.

Fortunately there is a tendency towards rapid elimination from the position of head of departments of persons whose mental attitude is unstable, so that ordinarily only the best fitted person is chosen and retained for each position. Only those who have the ability to formulate definite practical plans, and to adhere to them, are likely to attain and keep the positions of heads of departments. A person in this position must possess capacity of original thought applied to his particular sphere of usefulness, but should not be burdened with personal conceit, because such a combination is practically always lacking in judgment, and the incumbent of a position who possesses a combination of these qualities is quite certain to permit a desire to gratify his personal conceit to overshadow his tendency to do that which will result in the most good to the institution.

Any change in the method of performing any given duty should not be made until the head of the department has carefully studied the effects that such a change will have, not only for the moment, but during the fixed use of the changed method for a definite period of time.

One should bear in mind that an accustomed method which has been in use for a sufficient period of time to become thoroughly established, so that every one connected with the department knows precisely what every other one in this department would do under given conditions, must produce vastly better results, both as regards quality and quantity of service, than a new procedure,

which must be acquired by every one in the department; although the latter may seem to possess advantages from the theoretical or even from the practical standpoint.

One of the great advantages in adhering to an old and thoroughly tried system lies in the fact that experience has demonstrated not only its strong but also its weak points, and the person accustomed to it is prepared to cope with all probable emergencies. The experiences in this direction are especially expensive if methods are constantly changed; the service being found to suffer both in quality and quantity.

In reviewing personal experiences in hospital management it seems that more harm has come to the upbuilding of institutions from time to time by failing to adhere to this principle than from almost any other cause.

This principle applies to every department of the institution, but more especially to the service of the medical staff, and the nursing staff, than to any other.

No one denies that if a manufacturing enterprise changed its employes from one machine to another every few days, or weeks, or months, a failure in utility would result. If a mercantile or banking institution, or a railroad, were to do the same, it would mean bankruptcy within a relatively short time. If changes of the kind were made in the conduct of a hotel, or in the conduct of any one of many human enterprises, experience has shown that failure would be inevitable, and still in the management of a vast majority of our hospitals, in the manner in which they are conducted at the present time—so far as the resident medical staff is concerned—the changes are so frequent that nothing but confusion can possibly result. This is not true to quite so considerable an extent in the department of nurses at the present time as it was formerly. But in these two departments there is still much improvement to be obtained in this special direction.

The argument is constantly made that it is a part of the business of the hospitals to train the members of the medical staff, and to train the pupils of the nurses training school. In order to make the training comprehensive it is necessary to permit these pupils to serve in every possible capacity. In this way, however, the wide range of training is secured at the expense of thoroughness, and the pupil not having had an opportunity to become thorough in any one thing is most likely to be shiftless in everything. Personal tests of this fact made experimentally have demonstrated that some assistants, if changed from one service to another every few weeks or months, will be almost worthless, while if kept on the same service for at least six months they

become exceedingly valuable, not only to the service itself, but to themselves, because they have developed character and thoroughness throughout their work.

The same plan has been tried in connection with the training school for nurses. Instead of causing confusion in the institution by constantly changing a nurse from one department to another, the younger pupil is kept upon the same service for a period of three months, and the older nurse for a period of six months; the pupils thus learning the work in question, and at the same time furnishing to the institution valuable service.

In hospitals with various departments it might seem unfair to the pupil nurses should they fail to obtain equal services, for instance, in the male and female wards, in the children's and obstetrical wards, etc. Schedules have been arranged for nurses in which many of them were changed every week or fortnight, or at the longest every month. But it is not difficult to see the result of such a foolish plan upon the development of the institution. In the section upon the management of the various departments this will be further discussed.

APPOINTMENT OF OFFICERS.

In the appointment of officers for hospitals the Trustees must necessarily be limited by their financial resources, both as regards the number and quality of officers. As a general rule it is better to have a very small number of officers with excellent qualifications than a larger number without these elements, because the housing and feeding of incompetents is no small item, although the salaries may be insignificant. Aside from this there is always the expense occurring through a faulty economy of persons with poor judgment and who are unqualified to perform their work, and this results in a large item.

In order to make this point especially clear, two parallel cases are given of hospitals of about equal size, with the corresponding salaries paid.

No. 1.

Superintendent of Hospital	$ 4,000
Superintendent of Nurses	1,200
Assistant Superintendent of Nurses	900
Bookkeeper	1,200
Assistant Bookkeeper	600
Druggist	600

Stenographer	600
Office Clerk	240
Nine additional persons, including office boys, orderlies, etc., with an average salary of $200 a year.	
Total	$11,140

No. 2.

Superintendent of Hospital	$ 1,800
Superintendent of Nurses	1,200
Assistant Superintendent of Nurses	900
Bookkeeper	400
Office attendant	300
Stenographer	360
Total	$ 4,960

The difference of maintaining the officials of these two institutions is not alone in the salaries, but in the housing and feeding. The eleven additional employes cost the institution at least $3,000 a year for their maintenance. Their necessary incompetence makes them, moreover, exceedingly wasteful, so that, all in all, the expense of the one institution is more than three times as great as that of the other.

It might be suggested that the services of a superintendent drawing a salary of $4,000 must necessarily be more valuable than the services of one drawing $1,800 a year. As a matter of fact, in this particular instance the one drawing a salary of $4,000 was selected because he had made a failure in life, and was unable to earn the amount necessary to supply his own wants and those of his family, and he had the good fortune to possess friends upon the Board of Trustees who could supply suitable means for his existence.

On the other hand, the gentleman receiving $1,800 a year had been successfully employed in institutional work, in which he had received only a small salary, so that he could afford to accept this honorable position in a philanthropic institution for the sum of $1,800. His former experience fitted him to manage the institution in an economical way, making the most of the amount of money at his disposal. He had previously built up an institution from almost nothing to a respectable proportion, and was consequently chosen, not because he needed the position, but because the institution needed a man who had shown by his past work that he had powers of organization, and the enthusiasm necessary to assist the institution in its progress.

It will be seen that the salaries of the two most important officials in a hospital, the superintendent and assistant superintendent of nurses, are the same in the two examples given. The salary of superintendent of nurses has become relatively fixed and few capable nurses receive less than $75 or more than $150 per month; so that the element of graft is less likely to be introduced into the employment of the superintendent of nurses, than into the employment of other officers of hospitals.

From this point on there is again a marked difference in the stipends. The bookkeeper in one institution receives more than twice the amount of the one in the other. An examination of the books, however, shows those in the latter institution to be simpler, more easily comprehended, and equally as efficient as those in the former. This, however, was due to the fact that the books in the latter case were arranged by an expert of great ability, whose office it is to audit the accounts, in connection with two other gentlemen of the auditing committee, every month. (Such a system of bookkeeping will be found given in detail under a separate heading.) It should be stated that in the first instance the bookkeeper is a man, in the second instance a young lady who chooses to occupy this honorable position in preference to earning a larger salary in the employment of some business house. Factors of this kind come into play in the employment of most of the officers of a hospital. Of course, if the institution is financially able to pay good salaries, it is scarcely fair to take advantage of the willingness of employes to work for smaller pay than they would be willing to accept for a similar amount of work elsewhere.

Again, in the one instance a druggist is employed, in the other, the preparation of drugs is a part of the duty of one of the members of the resident staff, who receives no salary.

In the first example all of the other employes not corresponding to those in the second occupy their various positions through some outside influence, not because the hospital stands in need of their services, but because some one wishes them to have this kind of employment. The cause of all of this lies in the fact that some one secures positions for his friends as a favor to them without regard to the interests of the institution. This illustration has been used so that any one interested in hospital management can reason from the conditions outlined to those in his own.

There is always a great temptation to those in authority to use their influence to have persons appointed to various positions outside of their own department, because the friends of such

persons constantly appeal to every one connected with the institution.

The physicians, for instance, are asked to use their influence to secure the appointment of nurses in the training school; the superintendent of nurses is appealed to, to secure employment for persons in the matron's department, and so on.

It is better for the various heads of departments to have a definite understanding in accordance with which each person is to be the absolute judge of those under him, no matter what any other official has recommended in the case of any given employe. Moreover, in recommending an employe to any one of the departments, the employe should be told that his position in that department depends entirely upon his ability to satisfy the requirements of the officer at the head of the department in question. An endless amount of annoyance can be avoided in this manner, and the institution can be vastly benefited.

The ultimate control should, of course, always rest with the Board of Trustees, and should extend to every individual employe through the channels indicated in the diagram of authority; but it is a mistake for any member of the Board of Trustees to undertake the employment of any one under the heads of departments. For instance, the matron must select the cook; the superintendent of nurses, the orderlies and chambermaids; the superintendent of the hospital must select the engineer, the elevator man, and so on.

If these various persons do not possess the judgment necessary to select their assistants properly, then they should be removed and others selected in their places.

The term of office in this instance should be during the good behavior and competence of the person employed, except in State, County, or City institutions, in which it may seem best to have the term for a definite period according to the rules of civil service. This period should not be less than four, nor more than ten years. There should, however, be a definite understanding according to which the old employe should always have the preference, other things being equal. In other words, his reappointment should be a certainty if he possesses qualities equal to those of his competitor on the eligible list. This gives the institution an opportunity to improve the service without dismissing an employe whose only failing may consist in the fact that he has not made a reasonable amount of progress during his term of service. It might not be fair to place the stigma of dismissal upon this employe, and still it might not be fair to the institution to suffer indefinitely because of the lack of energy and enthusiasm which might be reasonably expected of any given employe.

THE SUPERINTENDENT.

The duties of the Superintendent of the hospital are so clearly defined in the diagram of authority that it is not necessary to mention them further in this discussion.

DUTIES OF THE MATRON.

As shown in the diagram of authority, the matron's duty should compass the entire care of the hospital. In institutions having a general superintendent, or a medical superintendent of the hospital, the matron will perform her duties under his direction. She will have under her care the kitchen department, the laundry department, and the general cleaning of the hospital. In case there is no general superintendent, she also has under her care the heating, lighting, the elevator service, and the general supervision of the various departments in the hospital. In this case she will receive her orders from the President of the Board.

CHAPTER IV.

THE MEDICAL AND SURGICAL STAFF.

The selection of the medical staff is one of the most important in the organization of hospitals, especially because there is so little precedent.

The plans followed in a few of the great hospitals in the older cities of this country, and those adopted in the great hospitals in Paris, in the hospitals connected with the medical department of German universities, the great hospitals in England, and those connected with medical schools in other European countries, were all carefully considered at the time they were established. But they all date back to a time when medicine and surgery in these hospitals were on an entirely different basis from that which they occupy at present.

With the introduction of these new conditions new features have constantly been added, but these have not always or entirely eliminated the features of the old system, which can no longer be employed with advantage; and it seems as though much more satisfactory results could be obtained if the good points were selected from the various systems and were applied to the different conditions as they exist at the present time. This has been done in a few institutions during the past twenty years, and as a consequence they have made phenomenal progress as compared with other institutions which have been developed side by side with them.

The selection of the medical staff for a hospital is one of the most difficult tasks possible, because the practice of medicine and surgery is to so great an extent a personal matter. A most excellent physician in private practice may not be capable of doing the best hospital work, because he lacks system; he may not be able to organize his assistants, or he may not possess the qualities necessary for working harmoniously with colleagues.

Outside of a few of the great cities in this country the number of physicians and surgeons who have done active work in hospitals is so small that no definite system of selection can be developed as yet.

For the present, therefore, the selection of members of hospital staffs must depend upon the following principles:

The men chosen must have such qualifications as will make their services more useful to the institution than would be the services of any other available persons.

New members of the staff should always be selected from the men who have been recommended for the vacancy by the existing staff. This will insure harmony, which is absolutely essential to success.

In foreign countries the staffs of hospitals are divided into departments and each department has virtually a staff separated from the other departments. On the continent of Europe there is chosen by the authorities a head of each department, and he in turn organizes his department as an independent unit by selecting his own assistants.

Whenever a vacancy occurs in the head of a department in one of the important hospitals many men who have served for years as assistants in similar departments in other great hospitals apply for the position, and so it is a relatively easy matter to fill such vacancies with thoroughly trained physicians and surgeons. There are many men who serve for years in the great university clinics as first assistants; after slowly attaining this position by doing conscientious work from the time they were appointed to the position of fourth or fifth assistant, in order to be prepared to occupy the position of chief of a department when some vacancy occurs. So far this plan has not been followed, as a rule, in this country.

In most institutions, a physician or surgeon is usually appointed to a position upon a hospital staff because he has been the family doctor of some member of the hospital board; because he has political influence with some public officials in city or county hospitals; and too often because he is an influential member of the church supporting the institution in question; or because he is a prominent member of the staff of another hospital in the same city. The effect of such a method of selection must at once be apparent. The first three reasons must result in dangerous selections, the last reason eventuates in the selection of men whose interests must naturally be with their old institution, and they consequently accept the second appointment for one of two reasons: viz., (1) it will keep a competitor from obtaining the position; or (2) the appointment may have some value from the standpoint of legitimate advertising.

It is strange but true that hospital Boards will appoint incapable persons to these important positions for personal reasons,

while in their business they would not tolerate any one who did not have the proper qualifications for performing the work required of him.

At the present time it would be wise to demand of any member of a staff, as a condition of his selection, that he must confine his hospital work to the institution in question. In this manner the institution can obtain the entire energy and influence of the man, but must in turn furnish him honestly with the best local facilities for fear of losing him to a competing institution.

No hospital can obtain great distinction for its work unless it follows the continental plan of having one head of each department, together with the other members, arranged after a definite system of authority. The number of heads in each instance would naturally be the same, but in the smaller institutions one man might serve as head of several departments.

In large hospitals, in which the work of any one department cannot be performed by one man, it is best to have the department under one head, and to have the work of the assistants under this head so arranged that there can be no confusion.

In most large American hospitals the service is divided among a number of men, so that each member serves for a definite number of months; or in other institutions the service is arranged so that each one receives his cases in rotation. If there are four men on any given service, case No. 1 goes to the first man on the staff, case No. 2 goes to the second man, and so on. This leads to an endless amount of trouble because of the partiality of those whose business it is to admit patients. The objection, however, has been successfully avoided in some hospitals by assigning all cases admitted to the general wards to surgeon or physician No. 1 from the first to the eighth of each month; those admitted from the eighth to the sixteenth, to No. 2; those admitted from the sixteenth to the twenty-third, to No. 3, and those admitted from the twenty-third to the thirty-first, to No. 4.

In case the service is divided between three men, those admitted before the eleventh are assigned to No. 1: those admitted from the eleventh to the twenty-first are assigned to No. 2; those admitted from the twenty-first to the thirty-first are assigned to No. 3. Each man continues to care for the patients which were referred to him during the time he was on active duty; he also cares for any cases that are sent to the hospital with a request for this particular member of the staff, and also those which he may send to the hospital personally.

In this manner the patients in the hospital receive better care because the physician can systemize his work, so that while he is

on active duty he will be constantly prepared to meet the emergencies which may occur in the hospital, while during the remainder of the month his time at the hospital can be limited to a definite and convenient portion of the day. The result is that the physician or surgeon maintains a continuous interest in the institution throughout the year, and he can consequently develop a degree of system in his work which would not be possible were he to serve for a few months at a time, and then be entirely off duty, according to the systems which are in vogue in many American cities.

The scheme on page 59 indicates a reasonable plan for the organization of a medical staff with definite lines of authority.

DURATION OF SERVICE.

In public institutions it is probably best to have definite periods of service. In different European countries this varies greatly, and in this country there are only a few of the oldest institutions that have a prescribed tenure of office.

The plan of dividing the service into four active periods of six years each and thereafter placing the physician on the consultation staff is probably the best. This would include six years of work as interne and third assistant in any given department, or two years' service as interne and four years as third assistant in one or more departments. The last four years of this work would be spent largely in pursuit of scientific investigation or research work.

The next six years would be spent in the capacity of second assistant or junior attending physician or surgeon. Most men would naturally not go further than this appointment, because the number of positions would become fewer as their importance increased. In each case the position in the higher class which would become vacant by time limit or resignation, or other causes, would be filled by the most suitable men in the lower ranks.

The next six years would be spent in the position of first assistant or attending physician or surgeon; and the following six years as chief of the department. After this the service would be in an advisory capacity, without any responsibility, for an indefinite period.

With such a scheme the authorities of a hospital can demand regular systematic service, and there must necessarily be developed in this manner a staff of unusual ability, learning and skill, which is scarcely possible by any other course.

In order to facilitate the practical application of the ideas involved the following plan of organization, which has been in

force in one of our large hospitals (and which has proven eminently successful), may serve as a practical example.

PLAN FOR ORGANIZATION OF HOSPITAL STAFF.

1. CONSULTING STAFF.

The consulting staff should consist of men who are distinguished for their learning and skill and who have served upon the active staff for a number of years, but are no longer able so to do because of their advanced age, on account of some physical infirmity, or owing to lack of time in view of other duties.

The members of the consulting staff should be ready to be called in consultation by the members of the active staff in unusual cases in which their advice may be desired.

2. ACTIVE STAFF.

The active staff should consist of:

1.—A chief of the entire staff.

2.—A chief of each department.

3.—An attending physician or surgeon in each department.

4.—A junior attending physician or surgeon in each department that is sufficiently large to demand this additional member.

The following division of the staff would result:

1.—Chief of the entire staff.*

*In case the occupant is a surgeon his title should be Surgeon-in-Chief; in case he is a physician, his title should be Physician-in-Chief.

Chief of entire Staff	Chief of Surgical Department	Attending Surgeon Junior attending Surgeon	Resident Staff consisting of Senior and Junior House Surgeons and Physicians according to the size of the Hospital.
	Chief of Medical Department.	Attending Physician Junior attending Physician	
	Chief of Obstetrical Department	Attending Obstetrician Junior attending Obstetrician	
	Chief of Neurological Department	Attending Neurologist	
	Chief of Ophthalmological Department	Attending Ophthalmologist	
	Chief of Otological Department	Attending Otologist	
	Chief of Dermatological Department	Attending Dermatologist	
	Chief of Laryngological Department	Attending Laryngologist and	
	Chief of Rhinological Department	Rhinologist	
	Chief of Pathological Department	Resident Pathologist	

ORGANIZATION OF STAFF.

In some hospitals the division into departments is somewhat different, there being a separate department for the eye, and a separate department for the ear; or the department for the eye, ear, nose and throat may all be under one chief. Such details can, of course, be altered to suit conditions.

INTERNES.

The number of internes should depend upon the number of beds—one interne for every thirty to forty beds. Their service should be for a period of from one to three years, according to conditions.

EXTERNES.

There should be two externes for every interne. Their service should be for a period of three to six months, according to conditions.

STAFF DUTIES.

The duties of the various members of the staff should be as follows:

The members of the consulting staff should have no active duties.

It should be the duty of the Chief of the entire staff to organize the service in general. He should be responsible to the Board of Trustees for the work of the staff, and should communicate to the Board any requests or suggestions which the medical staff may desire to make, and should receive from the Board any communications their body may wish to convey to the staff from time to time.

He should have the duties of Chairman of the Medical Staff at their meetings.

It should be the duty of the chief of each department to organize his own department, and to communicate to the Chief of the staff any requests or suggestions which the members of his department may desire to make from time to time.

He should be responsible to the Chief of the entire staff for the work of his department, and he should confine his activity in the hospital to his own branch of the profession.

He should have fixed days and definite hours of visiting the hospital, and should develop a systematic service. He should plan the work for the other members of his department.

It should be the duty of the attending physician or surgeon to take the place of the chief of his department in the latter's absence from the city, or in case of incapacity, and to assist the latter in carrying out the regular work of the department as out-

lined by the chief. He should also have definite days and hours of service. His activity should be confined to his especial branch.

ASSIGNMENT OF PATIENTS.

Every member of the staff should have the privilege of sending his patients to the hospital to be cared for in the private rooms, in the private wards, or in the general wards as he and they may desire.

Patients coming to the hospital should be assigned by the Chief of the entire staff, or by some one whom he may designate to the chief of the department to which they may belong, according to the character of their malady.

The chief of each department should care for these patients himself, or assign them to the attending physician or surgeon in his department, or to the junior attending physician or surgeon, according to the plan followed in the organization of his department.

If the service is a large one, so that it must be divided into a number of portions in order to secure satisfactory attention, it is well at this point to make use of the plan mentioned above of having all the patients in a given department assigned to one of the attending physicians or surgeons for a certain number of days, and then for an equal number of days to the next attending physician or surgeon, and so on throughout the month, so that each man upon the staff has certain days in the month when he has the entire service in his department. The reasons for this plan were given in our discussion above.

APPOINTMENT OF THE STAFF.

The original staff should be appointed by the Board of Trustees in accordance with the following plan:

The chief of the entire staff should first be selected by the Board of Trustees, then a conference between this chief and the Board of Trustees should be held. At this conference the men to take charge as chiefs of the most important departments, such as medicine, surgery and obstetrics, should be appointed. These should then act as a nucleus of a medical staff, and should locate men for the less important positions, whom they should in turn recommend to the Board of Trustees. In case any member recommended should fail to be elected, then another should be nominated by the original members of the medical staff for consideration by the Board of Trustees. In case of his rejection, there should be a repetition of this step until the person has been found

by the medical staff who would be satisfactory to the Board of Trustees.

For subsequent appointments the following plan should prosper:

For any appointment in any department in which a vacancy may occur the initiative should always come from the chief of the department—i. e., the chief of the department should recommend to the Chief of the entire staff a person who in his judgment is especially fitted to fill the vacancy because of his learning, skill, honesty, tact, modesty, industry, and especially his possession of an abundance of common sense.

The Chief of the staff should then call a meeting of the staff, and should ask each member of the staff already appointed for his opinion concerning the new candidate. If the person in question is satisfactory to the existing staff, then the Chief of the staff should recommend his appointment to the Board of Trustees. After due deliberation the Board should appoint the person recommended, or reject him, according to the judgment of its members.

In case a candidate who has been recommended by the staff is rejected by the Board, the whole process should be repeated and another recommendation made until a suitable person is found.

Another plan which has also been employed, and which has some advantage inasmuch as it may facilitate the election, in that it compels the Board of Trustees to make a choice, has the disadvantage of compelling the medical staff to recommend men who may not be perfectly suited to the position.

According to this system, the medical staff has three candidates for every vacancy, signifying its preference as to first, second and third. The Board of Trustees is compelled to choose one of these three candidates without regard to the preference signified by the staff, although ordinarily this preference would be considered. The difficulty in this plan lies especially in the fact that it will many times be almost impossible to find three men who could suitably fill a given position.

In case any member of the staff has any serious objection to the recommendation of a candidate whom the chief of any department may suggest, this candidate should be discarded and the chief of the department in which the vacancy may exist should select another candidate.

The appointment should be for one year, with the understanding that the Board will renew the appointment every year so long as the member of the staff performs his duties honestly, skillfully, and punctually.

In case two-thirds of the members of the active staff should deem it best for the welfare of the institution to secure the removal of any member of the staff, their written request to the Board should cause the latter body to forego his reappointment at the end of the year, and to notify the staff of the vacancy.

This feature is desirable because of cases in which members of the staff have become incapable of performing satisfactory service for the institution, either from physical, mental or moral incapacity. It has often been difficult to relieve the institution from this burden without causing a most unfortunate scandal. The plan mentioned would not, however, be safe unless the Board of Trustees were permanent, as indicated above in the organization of trustees.

SELECTION OF THE STAFF.

In selecting members of the staff, it seems that the following plan would give the best results for the hospital.

All members of the staff should be chosen because of their superiority in honesty, learning, skill, modesty, tact, industry, unselfishness, kindness, sincerity and punctuality.

The chiefs of departments should be men of distinction. In the great cities in which there are medical schools it is preferable that they be professors or instructors in one of the important schools. Whenever possible the junior attending physician or surgeon should be promoted to this position in case of a vacancy, provided he has developed the necessary qualities fitting him for the increased responsibility.

The junior attending physicians and surgeons should be still younger men, especially noted for their ability as students; men who are willing to give a considerable amount of time to scientific study and original investigation under the direction and advice of the chiefs of the various departments.

The resident pathologist should be a man who has given especial attention to the branch of pathology in one or more of the great laboratories in this country or abroad. He should give his entire time to the hospital, and he should be paid a suitable salary.

SELECTION OF INTERNES.

The internes should be selected by the Chief of the staff, with the advice of the chiefs of the various departments, from the men who have served as externes, the excellence of their service determining their selection. All internes should be graduated within one year previous to their appointment.

SELECTION OF EXTERNES.

These should be chosen by the Chief of the staff from applicants from the various important medical schools, each applicant being required to bring two satisfactory letters of recommendation from members of the faculty of his school. They should pass a competitive examination or should be required to have a creditable standing in their classes. They should have completed the sophomore, and probably the junior, year in their course at the medical college; and they should serve a period of from three to six months in the capacity of assistants to the internes.

This plan contains the following important features which must result in the formation of a staff which will be recognized everywhere as the best possible under the conditions existing in most hospitals:

It will insure stability in the staff, because the reappointment is insured for all time so long as the occupant of a position is physically, professionally and morally competent to fill this position.

It will enable men of great skill and learning to concentrate their energies upon the development of the institution, because they can feel certain that they are building up a work of which they are permanently a part. They can afford to be liberal with the poor and those in moderate circumstances, because they will have a place where their wealthy patrons will get the best possible care; and the fact that provision is made for the care of wealthy people will ultimately result in large endowments which will support the institution for the poor for all time to come.

This feature applies, of course, only to the hospitals containing both private rooms for the care of wealthy patients and wards for the care of the poor.

In case of hospitals devoted entirely to the care of charity patients the benefit to the members of the staff must come through the fact that the institution enables them to increase their learning and skill, and to give them an opportunity of utilizing the patients for clinical teaching.

This course makes a harmonious staff absolutely positive, because each new member will be selected by the staff of the department in which he is to work, and will be accepted by all the other members before he is appointed by the Board.

It will make it possible for the chief of each department to develop the ability, skill and learning of the other members of his department, because being chief, and having selected these members himself, they will be men whom he will be able to trust.

The fact that they have been accepted by the other members of the staff will make it certain that his selection has been for the best interests of the institution and not for selfish purposes.

The younger members of such a staff will be sure to obtain appointments in other important institutions after having served sufficiently long to have acquired skill and learning, consequently there will not be the tendency to intrigue against their chief in the institution in question.

It will be necessary to pay a salary to the resident pathologist, because he must be a man of unusual learning and must give the institution his entire time. During the three years of service, however, he will have an opportunity of creating a reputation that will make it possible for him to secure a position in some university at the end of that time, should he desire it. The salary should be graded, being approximately doubled each succeeding year for three years, which will make the average sum a little greater than that received for the middle year.

As indicated above, this composes the organization of the staff of a large hospital in a large city conducted under the auspices of a church organization.

A careful study of this plan will convince one that it possesses exceedingly strong features, provided a man of unusual ability can be secured for the head, who will concentrate his energies upon his particular institution. Were he to follow the foolish plan of dividing his energies among a number of enterprises, it would necessarily mean bankruptcy for the institution in question, because its success must obviously depend upon the ability, judgment, energy, enthusiasm, concentration, punctuality, and powers of organization of this head.

In discussing this form of organization, it has been urged many times that the loss of such a head would again of necessity destroy the prosperity of the interests under charge; and that the disability of this head would mean disaster to the institution. This is an argument that would have weight only in case such positions were not sought after by men of unusual ability. On the continent of Europe experience has shown for many years that there is no danger from this source.

Another objection lies in the fact that this system places undue powers in the hands of one individual, which if used for selfish ends, would again harm the institution. Such an event would, however, ruin the prospects of the individual at the same time, consequently he could scarcely afford to take chances, even though he might primarily be moved by selfish motives. Probably the only conditions allowing of the above are afforded in

largely endowed institutions, because here the bad results of such a selfish practice would not lead to bankruptcy. In such institutions, however, it would be very foolish not to provide necessary precautions in the management of the finances, which would again make it almost impossible for unscrupulous men to get the position of heads of departments.

The form of organization provides another remedy which could be applied in case the chief of any department failed in this direction. The Board of Trustees in the annual election of the medical staff could leave the vacancy in this particular department, and call upon the staff for nominations from which to fill this vacancy.

Another possible fault has been hinted at above. The possibility of appointing incompetents to the subordinate positions like those of attending physician or surgeon, or junior attending physician or surgeon, from selfish motives on the part of the chief of the department, or because of fear of competition from an unusually capable person in any one of the subordinate positions. This contingency would be favored by the fact that the initiative in all of these departments in the appointment of such physicians and surgeons must come from the chief. The latter, however, having only the right to nominate, will naturally not propose a person whose lack of ability will cause him to be undesirable as a colleague to the remaining members of the staff, any one of whom has a right to prevent his acceptance by objecting to the recommendation of this person to the Board of Trustees.

The system should contain a reasonable age limit, or a limit in the number of years of service. In the European centers there is an age limit of seventy years, which for the conditions in this country is possibly five years too high.

In some of the other countries the service is limited to from fifteen to twenty-five years as chief of a department. The latter period seems to be the more desirable for obvious reasons.

This form of organization could not be applied to smaller hospitals, neither could it be applied to the very large institutions under the control of the State, City or County. For these we must provide other plans.

In cities of moderate size, say up to 100,000 inhabitants, in which there are not more than two or three hospitals, the course just described is applicable with the addition of the following features:

In such cities there are many capable practitioners of medicine who are perfectly competent to serve upon the staff of a hospital, and whose service in such a capacity would not only benefit

the community, but also the institution; but it is self-evident that an unlimited staff would be ruinous, just as an unlimited number of foremen would be ruinous to the conduct of a factory.

These medical men are often very nearly equal in their qualifications, therefore beyond the selection of the staff as indicated above it would be difficult to place all of the other available men so that they would be properly graded, and so that there would be proper lines of authority. Still, provision must be made which will render it possible for physicians and surgeons in the city, who are willing and able to perform such work as will be beneficial to the community and the hospital, to treat their patients in the institution, provided they are not affiliated with any other similar institution in the city. This can be accomplished in the following manner: There can be the organization of a staff as indicated above, which will be known as the executive staff, and the members of this staff will be known by the titles indicated above. This staff must necessarily be limited to new members, and can be chosen only when vacancies occur.

There can be organized a second staff whose members are selected by the executive staff, precisely as are the members of the executive staff itself. They are then recommended to the Board of Trustees by the president of the executive staff, and if elected by the Board of Trustees, their service should continue indefinitely; the Board of Trustees re-electing each member annually unless there arise some reason or reasons which would make the continuance on the staff undesirable, or unless either the executive staff, or the visiting staff, by two-thirds vote, recommends to the Board of Trustees that a certain member should not be re-elected, in which case the Board of Trustees should comply with their request.

The members of the visiting staff should have the privilege of treating their patients in the hospital under the same conditions accorded to the members of the executive staff, but the rules governing these conditions should be made by the executive. In other words, the members of the executive staff should make all the rules concerning the regulation and management of the medical and surgical care of patients in the hospital; but these rules should apply alike to members of the executive staff and members of the visiting staff, with the one exception that members of the visiting staff would treat only such patients as are sent to the hospital by themselves. Patients going directly to the hospital should be distributed among the members of the executive staff according to the plan previously described.

In this manner every physician and surgeon who has the

professional, mental and moral qualifications which fit him to perform hospital work can be given the opportunity if he desires it.

In case of vacancies occurring in the executive staff these should be filled from the junior members of this staff, providing these members have the proper qualifications; and their places in turn should be filled from the members of the visiting staff.

In the event, however, of some member of the visiting staff demonstrating to the Chief of the attending staff, in whose department the vacancy exists, that he is superior in his qualifications to any other available members of the attending staff, then the preference should be given to such member who seems best qualified to fill the position.

The same is true in case a vacancy occurs in the position of chief of any department. Should a member of the visiting staff be better qualified, in the opinion of the remaining members of the attending staff, to fill this vacancy, then the preference should again be given to the member of the visiting staff.

There is a distinct advantage in this procedure from the fact that competent men will be willing to serve upon the visiting staff in order to have an opportunity to show their qualifications so that they may be available for appointment upon the attending staff when a vacancy occurs. It will further tend to make the service harmonious, because every member of the visiting staff will know that this is one of the conditions necessary to make an appointment to the attending staff possible. This method has been tried and found satisfactory.

In hospitals with no large wards, members of the visiting staff can have their patients so placed that they are together in as many wards as the number under the care of the visiting physician in question demands.

In considering the subject of hospital construction later on the use of only small wards will be found advised, four beds being the most satisfactory number, but six or eight being permissible. The maximum of comfort and convenience to the patient, and to the physician, especially in hospitals in which there are many patients, is greatly increased in this way.

In every small town in which no practitioner confines his activity to any given field of work, because there is not sufficient amount of such work to occupy his entire time, it is often very difficult to arrange the service in the hospital, perhaps because the patients have formed very strong personal attachments to the various members of the local profession. Under these conditions

it has been found satisfactory in many instances to conduct the hospital without an appointed hospital staff, but to permit every reputable physician in the town to bring his patients to the hospital, and to care for them as though they were in their private houses.

CHAPTER V.

PLANS FOR THE ASSIGNMENT OF PATIENTS.

In order to prevent confusion, it is well to provide each practitioner with envelopes bearing the name and address of hospital, a blank space for the name of the patient, a blank space for the name of the physician. The physician writes a letter containing all the directions he may have to give, signs and seals it in this envelope, writes the patient's name upon it, and his own underneath. When the patient enters the hospital bringing this envelope, it is clear into whose service he has come, and this must necessarily relieve any confusion.

In almost every hospital which is organized so that many physicians and surgeons treat patients, the institution has had an endless amount of disagreement (which is always bad for its prosperity), because patients who entered the hospital upon the recommendation of one physician, through some error were placed under the care of some other physician. This frequently happens, even when every one concerned tries to be perfectly fair. It is, of course, more likely to happen when some member of the staff is especially admired by a person employed in the hospital office, or by some of the members of the resident staff, or by the nurses; but even if there is nothing in the conditions which would indicate favoritism, it frequently happens that these misunderstandings occur.

Where the system is employed which provides against this in the manner just described, the physician who loses his patient does it as a result of his own carelessness; because of the fact that the patient presents definite written orders which must, of course, be preserved and which makes an error in this direction under discussion practically impossible. It may happen occasionally that the patient will forget to bring his instructions, but in that contingency the person admitting the patient will take the proper means to determine who the patient was intended for, because he will have to account for the placing of every patient, either by producing the written directions, or by showing a reason for having assigned the patient without such directions.

In the staff which has just been described, composed of a visit-

ing and attending branch, this plan is especially important because all patients who do not come with a definite written request for a certain member of the staff, will be placed, as hospital patients, in the care of the various departments according to the diagnoses.

The practice of medicine and surgery is personal to so great an extent that to the uninitiated this precaution will appear as useless detail; but experience has shown that there are few contrivances which will do more toward establishing harmony in the staff of a hospital than this one factor of the utmost carefulness in the assignment of patients.

Another point which may be considered at present refers to the matter of precedent as regards the use of certain conveniences of the hospital. If it were possible to conduct an institution in which each member of the staff had his own conveniences throughout, the conditions would, of course, be ideal; but this is possible only when the physician or surgeon upon the staff has an unusually large practice and keeps the various items occupied a sufficient portion of the time to make the expense of their use in proportion to the benefits which the institution derives therefrom. This refers especially to examining-rooms, operating-rooms, dressing-rooms and similar conveniences.

In case no member upon the staff occupies these various apartments for a longer period than a few hours each day it is scarcely reasonable that so much space should be set aside for his exclusive use. We will consider, for instance, the operating-room in a hospital having a surgical staff of from six to ten members; unless some system is arranged there must necessarily be an endless amount of waiting and a corresponding amount of annoyance and confusion.

With so large a staff the hospital should contain at least two operating-rooms, and for institutions containing more than one hundred and fifty surgical beds, there should be at least three operating-rooms, in order that there would always be one room free in case of an emergency.

Annoyance and confusion also comes from establishing different hours and days for operation for the various members of the staff. In every institution with a large staff there must necessarily be some members who, either through lack of method or as a result of selfishness or disregard for the convenience of others, or again, as a result of personal conceit, cannot be induced to adhere to any definite order. Such persons are usually of very little value to the hospital, and the sooner their connection is severed the better it will be for the prosperity and development of the entire work. Once in a very large number of cases an

institution may lose the services of a genius by refusing to maintain upon its staff these erratic individuals, but such a possibility occurs so seldom that in a general way it is probably best to disregard it entirely, especially because in the medical profession it is in such cases very frequently most difficult to distinguish between genius and degeneracy.

Some consideration applies to the special attentions to which various members of the staff are entitled from the members of the house staff, the internes, the externes, the superintendent of nurses, the head nurses in the different departments, etc. If the members of the medical staff adhere to a definite schedule they can conveniently enjoy much attention which would otherwise be impossible to give because of conflicts in time. The most important part of this feature becomes plain when one considers that with a definite schedule the orders given by members of the staff can be carried out systematically, because they can be given to the proper person with the proper authority.

There is, of course, the possibility of carrying this matter to the extent of consuming so much time in red tape that there will be none left in which to perform the necessary work of the institution, which would be quite as bad as though there was a lack of system.

It is, however, possible to avoid both evils, if one is patient in the development of a system according to the principles indicated above.

In arranging the service of the resident staff it is important to bear in mind that the work of the members of this staff cannot be carried on with any degree of satisfaction unless the service is relatively permanent and fairly automatic.

If the attendant serves under any given member of the attending staff for only a few months it is impossible for him to fully comprehend the system desired by his chief. He then enters the service of a second member of the staff and carries with him the partly learned method of the first member, and so on through the entire course of his interneship.

It might be claimed that in this way he acquires many excellent methods of performing his work the better to prepare him thoroughly to do his work independently after leaving the hospital. As a matter of fact, however, he fails to learn any one method properly, and the result is as hopeless in the development of the interne as his service has been useless to the institution.

This difficulty can be remedied in hospitals that have a sufficient number of beds and employ a corresponding number of internes. By having a senior interne in each department on duty

for at least six months, preferably a year or longer, and requiring each interne to serve as senior in one department only, and to serve as junior or as externe without direct responsibility to the staff, but with responsibility to the senior internes in the other departments.

In this way the care of the patient does not suffer and still young men will have the opportunity of varied training, and an opportunity of responsible service before leaving the hospital. They will also look forward to the time during their service when they will carry an important responsibility in connection with the management of the institution. The dignity which goes with the service of senior interne has an excellent effect upon the discipline of all of the internes.

The cases requiring especially good judgment are naturally first seen by the interne, because they come to the hospital in the

Diagnosis	Region	No. of History
Name	Res.	Age
Service of Dr		S M W
Vol. P	Remarks	
Opt'n.		
Interne		
Admitted		
Discharged		
Result	Final Diagnosis	

EXHIBIT A.

character of emergencies. Cases of severe injury, poisoning, delirious patients, severe burns, patients entering the hospital in a comatose condition, and many other like instances, are first examined by the interne, who has been on duty at least one year before he is allowed to occupy this important position.

The following table will represent the service of internes in a properly conducted hospital of two hundred beds, of which one hundred are surgical, seventy-five medical, and twenty-five belonging to the special departments, such as eye, ear, nose, throat, skin, neurological and obstetrical. The patients on the obstetrical side being classed with the surgical patients, and the patients on

the medical side in the children's department being classed with the medical patients.

In order to avoid confusion it will be well for each department to have cards of a different color, which are placed in small holders on the doors of private rooms and private wards, the general wards belonging to each of the various departments, and in mixed wards which contain patients belonging to a number of departments. These cards should be placed upon a holder attached to the bed, or they should be attached to the record sheet of each patient, so that each member of the attending staff, and each member of the house staff, can at a glance distinguish his own patients from the others.

The use of a card similar to the following is a great convenience in preventing errors and confusion regarding the distri-

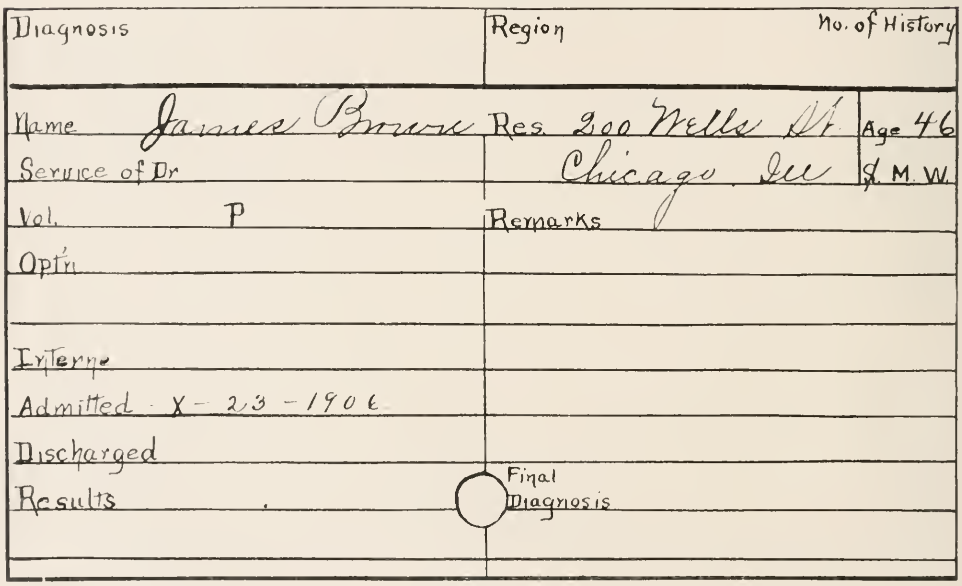

Diagnosis
Region
No. of History
Name James Brown
Res. 200 Wells St. Chicago Ill
Age 46
S. M. W.
Service of Dr
Vol. P
Remarks
Opr'n
Interne
Admitted X-23-1906
Discharged
Results
Final Diagnosis

EXHIBIT B.

bution of patients. When a patient is admitted to the hospital the clerk in the office writes the name and date upon the card as indicated in A. The card is then sent to the senior interne who has charge of the classification, and he determines the department to which the patient belongs. In case the patient brings a letter, this fact has been determined for him. If the patient does not bring a letter, the senior interne will make the examination and diagnosis, and determine the classification. He then selects a card of the color belonging to the department to which the patient is assigned, and adds the name of the attending physician, the name of the interne, and the provisional diagnosis (mentioned in a letter

brought by the patient, or determined by the interne from the history and examination).

In the first instance this places the attending physician who has sent the patient to the hospital, on record regarding the diagnosis. In the second, it puts the senior interne on record regarding the diagnosis. This fact eliminates a great amount of natural or habitual carelessness on the part of these persons.

The card then has the form shown under B. The senior interne preserves this form for the present as his own record of the case so far as it has advanced.

The interne in whose care the patient now rests adds the important facts concerning history, the treatment and progress of the case, and, when the treatment is completed, he puts down the result, the final diagnosis, and then he hands over the card to the senior interne, leaving the card in a form of which C may serve as a sample.

Diagnosis Cholecystitis	Region Abdomen	No. of History 3650
Name James Brown	Res. 200 Wells St.	Age 46
Service of Dr. Walter White	Chicago, Ill.	S M. W.
Vol. P	Remarks	
Opt'n. Cholecystectomy		
Interne Wm. Welch		
Admitted X-23-1906		
Discharged XI-15-1906		
Results Recovered	Final Diagnosis Cholelithiasis	
	6 stones in gall bladder, 1 in cystic duct.	

EXHIBIT C.

The senior interne copies from this card upon his own the portion shown in Exhibit D.

The card of the senior interne is then filed as a part of the general records of the hospital; the card of the interne in the given department, as a portion of the record of the given department.

Of course, these cards may be varied to suit the conditions of the service; it is important only to secure uniformity, and to insist upon having all of these slips carried out with regularity.

If desired by the attending physician, the important facts concerning the history and treatment of each case may be written on the reverse side of the card, so that the card contains all of the important points which might be desired for reference at any future time.

When the patient is referred from one department to another the card, according to this system, is transferred to the other department, the date of the transfer being noted upon the card. A new card bearing the color of the department to which the patient has been referred is then made out by the interne in such department; and this card should contain all the facts of card B, together with any additional information of importance which was determined by the department to which the patient was first referred, and which had been noted upon the card, also the date on which the patient was referred and the name of the department from which the patient was received. The other card is then re-

Diagnosis Cholecystitis	Region Abdomen	No of History 3650	
Name James Brown	Res. 200 Wells St.		Age 46
Service of Dr. Walter White	Chicago, Ill.		S.M.W.
Vol. P	Remarks - Dressed daily until		
Op'n Cholecystectomy - rub-	XI-15-'06, then 17-20-23		
ber-tube drainage thro' cystic duct	Tube removed XI-10		
Interne Wm. Welch	Free bile drainage until XI-15		
Admitted X-23-1906	Slight bile drainage XI-17-20		
Discharged XI-15-1906	Wound healed XI-23-1906		
Results - Recovered	Final Diagnosis Cholelithiasis		
	6 stones in gall bladder, 1 in cystic duct		

EXHIBIT D.

turned to the preceding department and filed as a record of such department.

This system provides, first, the responsible placing of each patient so that every one concerned knows to whom the patient belongs; second, the responsible recording of both the preliminary and the final diagnosis; and, third, a record of the various departments in which the patient has been treated, both in the general records and in those of each individual department.

In order to arrange such a system suitable for any given institution it is well for the staff to have a number of conferences

from time to time, because what would answer the conditions of one, might be quite out of proportion for another similar institution. There are a great many differences regarding the relative number of patients belonging to the various departments, and then there are further individual differences regarding the plan of management of the various individual members of the staff, so that it is impossible to draw hard and fast lines which would apply alike to all similar undertakings of this kind.

It is, however, always important to develop the plans suggested so that the whole organization will be as simple as possible, and still be sufficiently complete to eliminate the trouble which must come from every imperfectly organized system.

There are two features which every good system must contain, and which are incorporated in this plan—viz.:

First, definite lines of authority. Every member of the staff knows his superior and inferior officer; he is responsible in his work to one person, and those under him are responsible alike to him, and to him alone.

Second, no one without experience should have any great responsibility; neither should his duties be in advance of his position in the scale of development.

These principles must of necessity give strength to an institution, and they must also establish confidence in those whose support is sought for the work.

CHAPTER VI.

DISCIPLINE AND RULES GOVERNING STAFFS.

It is well to establish all of the minor points in the discipline of the house staff at the conferences of the attending staff, at which the house staff is present, because, as a rule, the members of the house staff are far better judges of such matters than are the members of the attending staff; and the result will be an arrangement which can be directly applied to the conditions in any particular. The fact that it has been virtually approved both by the attending staff and by the house staff, makes it practically certain that the point, or points, agreed upon will actually be carried out.

Regulations established in this manner have a fair likelihood of at least being somewhat reasonable, which is never the case if they are established either by the attending staff, or any one of the various officers of the institution.

If any one will take the trouble to examine the printed rules laid down in most hospitals of the class named, and will apply them to the conditions existing during one's personal service on the resident staff of the hospital, it is easy to see the hopelessness of trying to live up to such rules. In time, no doubt, certain fundamental rules will be established which will be applicable to most of these institutions.

The following rules have been adapted from those in force in one of the largest and most important hospitals in this country:

* * * * * * *

RULES FOR RESIDENT STAFF.

The resident medical staff shall consist of six or more members, of whom the resident physician and the resident surgeon shall be resident medical officers of the senior grade, and the resident physician for special diseases, the resident pathologist, the junior resident physician, and the junior resident surgeon shall be resident medical officers of the junior grade. They shall be appointed on nominations made by the medical staff, by the trustees of the hospital, for the term of one year.

The resident medical officers of the senior grade shall be

physicians who have had previous experience as externe and junior officers in a hospital for at least one year. They shall be nominated by ballot by the attending medical staff. Resident medical officers of the junior grade shall be nominated by the medical staff from a list established by a competitive examination, conducted by a committee of the medical staff.

Resident medical officers of the senior grade shall serve for one year in the hospital, for two periods of six months, as the resident physician of the medical division, resident surgeon of the first surgical division, and resident surgeon of the second surgical division. The one on the medical side serving continuously as medical officer of his department, the one on the surgical side serving six months in the department containing patients whose wounds are primarily aseptic, and six months in the department containing wounds which are primarily not aseptic. The service being concluded with the latter service, and the resident surgeon occupying the latter service shall be known as the first resident surgeon, ranking above resident surgeon occupying the former service, who shall be known as the second resident surgeon.

Resident medical officers of the junior grade shall serve for one year divided into periods of three months each, in the following positions: Resident physician for special diseases, resident pathologist, junior resident physician, and junior resident surgeon. Members of the resident medical staff shall elect the sequence of their service in order of seniority of appointment, or by mutual consent. A sequence of service once established should not be changed.

For the purpose of establishing the terms of service and of defining the duties of the resident medical staff, the following three divisions are established:

First—The medical division shall consist of the general medical service, the special departments for the eye, ear, nose, throat, skin, and nervous dieases. This division shall be in charge of the resident physician, and the junior resident physician.

Second—The first surgical division shall consist of all surgical and gynecological patients whose wounds are primarily not aseptic. This division shall be in charge of the first resident surgeon and the junior resident surgeon.

Third—The second surgical division shall consist of the obstetrical department, and of all surgical and gynecological patients whose wounds are primarily aseptic. This division shall be in charge of the second resident surgeon and the second junior resident surgeon.

The resident physician shall have charge, under the direction

of the medical staff, of the medical division of the hospital. He shall examine such applicants for admission to the hospital as the superintendent may direct, and report to the superintendent the nature of the disease, the probability of the relief or cure, and the division of the hospital to which the patient should be assigned. In this portion of his service he shall alternate every three months with the first senior resident surgeon. He shall register his diagnosis upon the index card. He shall also prepare an index card in the proper color of the department to which the patient has been referred. He shall, under the direction of the attending medical staff, recommend to the superintendent patients for discharge from the hospital, and enter upon the clinical histories and upon the index card of such patients a summary of the results of treatment and the condition of the patient on leaving the hospital. He shall have charge of, and be responsible for, all clinical histories and other medical records of the medical department of the hospital. He shall visit each patient under his care at least each morning and evening, and oftener if required, and shall make and record a physical examination of every case under his charge within twenty-four hours after entrance, unless otherwise directed, and on such other occasions as may be necessary. He shall report to each member of the attending staff the admission of patients under his special care. He shall accompany attending physicians on their visits, when possible, and shall report the state of each patient and the treatment each has received, and shall see that the orders of the attending physicians are properly executed. He shall record all prescriptions and directions for treatment on charts provided for that purpose. He shall, at stated intervals, enter upon the clinical charts a summary of the progress of the case since its admission. He shall compile and file with the superintendent of the hospital the monthly statistical report of cases in the hospital during the preceding month, on or before the fifth day of each month. He shall assign the junior resident to such other work in the medical department, not specifically described under the duties of a junior resident physician, as seems to him to be necessary, and shall himself perform such other work within the hospital, not specified above, as may be assigned him by the attending physician.

The junior resident physician shall perform the duties of the senior resident physician during his absence or temporary disability. He shall always be present in the hospital on such occasions.

He shall obtain and record the history and an examination of the urine of each medical case, within twenty-four hours after

entrance He shall make all chemical, microscopical and bacteriological examinations which may be required in the medical division, and transcribe the results of each examination on the clinical charts. He shall have charge of, and shall keep under lock and key, the electric batteries, immersion-lenses, blood-counters and other instruments of diagnosis, except the microscope and lower-power lenses. He shall give these instruments to the proper persons for use, but shall keep note of the same, and shall be responsible for the instruments. He shall pass the catheter, when necessary, upon the male medical patients and shall perform such other duties in the medical division as may be assigned to him by the attending or senior resident physicians.

Each resident surgeon shall have general supervision of all patients in his division of the hospital. He shall visit each patient in his division, at least every morning and evening, and oftener when required. He shall record all prescriptions and directions for treatment in charts to be kept for that purpose, shall accompany the attending surgeon on his visits through his division, and shall report the state of each patient to the attending surgeon, and the treatment each one has received. The resident surgeon shall be held responsible for full and accurate histories of every case which comes under his professional care. He shall, unless otherwise directed by the attending surgeon in charge of the patient, make a complete physical examination of each patient and record the results of it within twenty-four hours after the admission of the patient. He shall have charge of such surgical dressings as may be required in his division, and shall not delegate their performance to any person except by the express consent of the member of the attending staff in charge of the patient. He shall, at the conclusion of each surgical dressing, make a note in the clinical record of the patient, stating the condition of the dressing removed, the drainage, if any, and the progress of healing. He may, with the consent of the member of the attending staff in charge of the patient, direct his junior resident surgeon to perform such duties as he may require. He shall assume immediate charge of all surgical emergencies arising in his division of the hospital, but shall not give general anesthetics, nor undertake any capital operations without the consent of a member of the medical staff. He shall attend all operations in his division, as far as is practicable, and be ready to afford such assistance and to perform such other duties within the hospital as may be required by the attending surgeon. He shall, under the direction of the members of the attending medical staff, recommend to the superintendent patients for discharge from the hospital, and enter

upon the clinical histories of such patients a summary stating the results of treatment and the condition of the patient on leaving the hospital. He shall have charge of and be responsible for all clinical histories and other medical records of the department of the hospital under his charge.

The second resident surgeon shall render such assistance in the X-ray department of the hospital as may be required of him from time to time.

The first and second junior resident surgeons shall serve respectively in the first and second surgical divisions of the hospital. Each shall take, transcribe and file on charts provided for the purpose, full and accurate clinical histories and the result of the examination of urine of each patient admitted to his division, within twenty-four hours after admittance, unless otherwise directed by the attending surgeon in charge of the patient. Each shall make all chemical, microscopical and bacteriological examinations required in his division, without delay, and transcribe the results of such examinations on the clinical charts so that they may be made available in treatment. Each shall catheterize all male patients in his division when that service is required. Each shall act as anesthetist in all operations in his division, in so far as is practicable, under the supervision of the official anesthetist of the hospital. Each shall perform such other duties in his division as may be assigned to him by the attending surgical staff or the resident surgeons, and shall alternate with the other in responding to ambulance calls in the absence of the externe acting in this department.

The externe in the surgical department shall have charge of the ambulance service of the hospital and shall see that all regulations with regard to the same are enforced. He shall act as anesthetist under the supervision of the official anesthetist of the hospital when not on ambulance duty, and he shall be present in the operating room during the usual hours for operations. He shall have charge of the patients of the isolation ward, under the direction of the attending staff, and shall take and be responsible for all these clinical histories. He shall perform such other duties in the isolation ward as are prescribed for the resident surgeons in their respective divisions. He may be temporarily assigned by the attending surgeon to such other duties in the surgical divisions as the necessities of the service may require. He shall assist the junior resident surgeon, and be responsible to him in the performance of his duties.

Members of the resident staff, when in the hospital, are at all times on duty, except as below specified, and must be ready and

willing to render every service in their power. Each member of the resident staff shall have free for himself, each week excluding Sunday, one afternoon from two to six o'clock, and one evening, from seven to twelve o'clock, midnight. During these hours he is off duty and may be away from the hospital. No member of the resident staff shall leave the hospital at any other time, except on ambulance calls, unless he has the written permission of the superintendent. In addition to the above the junior resident physician and the externes may be off duty during Sunday morning until one o'clock, and the three others during the evening from six to twelve o'clock, midnight. The terms of "off duty" for each member of the resident medical staff, arranged in the beginning of each new service, shall be published as a bulletin in the office of the resident physicians and surgeons. They shall at each change of service arrange by mutual consent or by lot, for their respective terms of absence from the hospital, and shall each observe the rights of other members. One member of each division shall always be present in the hospital unless temporarily absent on ambulance duty.

Each member of the resident staff shall have, during each year of his term of service, not more than three weeks' vacation, two of which shall be during the months of June, July, August and September. The period of vacation shall be determined by mutual agreement among the members of the resident staff, with the consent of the superintendent and the members of the attending medical staff in whose department the resident officer is acting.

When any member of the resident medical staff leaves the hospital, except in case of ambulance calls, he shall note this fact and the time of his leaving in a book in the office provided for that purpose, and he shall arrange the bulletin-board so that the word "out" shall be opposite his name, and upon returning he shall arrange the bulletin-board so that the word "in" will appear opposite his name. It shall be arranged among themselves that a majority of the resident staff shall, at all times, be in the hospital unless one is on ambulance duty. Any leave of absence for a member of the resident medical staff for a longer period than six hours shall be in writing and granted only by the superintendent, with the approval of the members of the attending staff then on service in the same division, after provision has been made for the proper performance of the duties of the absentee.

When a patient comes into the hospital in a condition of immediate danger of death, or when a patient already in the hospital rapidly sinks into a dangerous state, the resident physician or surgeon shall inaugurate such treatment as he deems necessary,

and shall, as soon as possible, notify the attending physician or surgeon of the condition of the patient.

A female nurse shall always be present at all gynecological examinations; none such shall be made by a junior resident physician or surgeon, except by the direction of the attending physician or surgeon, save in cases of danger of life.

Members of the resident medical staff shall follow no other business or practice outside of the hospital, and are prohibited from receiving any fee from any person whatever for any service performed for any patient in the hospital.

It shall be the duty of the resident staff to fill out, free of charge, all death and birth certificates, insurance affidavits and other necessary medical blanks and certificates concerning patients who are or have been under their care.

The resident staff shall be called at — A. M. Breakfast shall be served only from — to — A. M., except by express permission of the superintendent. Each resident shall commence his daily hospital work at — A. M., or earlier if necessary, and shall, as far as possible, complete the routine hospital work before — A. M. The surgical resident staff shall, as far as possible, be ready for work in the operating room by — A. M.

All surgical dressings shall be made, except in cases of emergency, during the day tour of duty of nurses.

The resident physician and the resident surgeon shall begin their morning visits to patients at promptly — o'clock, and their evening visits before — o'clock.

All catheterizations of all patients shall be done by members of the resident staff.

All surgical dressings and irrigations for male patients shall be performed by members of the resident staff, unless the member of the attending staff in charge of the patient expressly consents to this duty being performed by some other qualified person.

Examinations of the heart, lungs and urine must be made in every case prior to operation, and the results recorded in the history sheet.

The junior resident physicians and the junior resident surgeons shall attend, as far as is practicable, all autopsies of cases in their immediate care, and enter upon the clinical histories an abstract of the pathological diagnosis and the immediate cause of death.

No member of the resident staff shall give any certificate or statement concerning the condition of any patient in the hospital, for legal or other purpose, without the authority of the attending physician or surgeon, except as previously provided.

For the lack of professional fidelity, attention or skill, or of personal courtesy, any member of the resident medical staff may, at the direction of an attending physician or surgeon, be suspended by the superintendent from duty pending final action by the board of trustees of the hospital.

Should any member of the resident staff feel aggrieved from any cause associated with his work, or become dissatisfied with his professional assignments, he shall state in writing the grounds for his dissatisfaction to the secretary of the attending medical staff, who shall, upon sufficient notice to the attending medical staff, give a hearing to all parties at interest and decide the questions involved in controversy. An appeal from this decision of the attending medical staff may be taken to the board of trustees for final disposal.

Members of the resident medical staff shall substitute for each other in response to urgency calls, and respond cheerfully to all requests of the superintendent and the attending medical staff.

To each member of the resident medical staff who passes creditably through the various grades of the service there shall be given, on his graduation, a diploma, signed by the superintendent, the president and secretary of the board of trustees, and the medical staff, under the seal of the corporation, stating the period of service.

Members of the resident medical staff before entering upon their duties, shall sign a statement that they have read the regulations and that they will faithfully perform their duties and observe the rules provided for them, and that they shall be under the immediate control and subject to the orders of the attending medical staff, and shall receive no diploma, as hereinbefore provided, unless they remain the full term of service to which they were appointed, and discharge their duties to the satisfaction of the attending medical staff, the superintendent and the board of trustees.

When for any reason it becomes necessary to fill a vacancy in the resident medical staff, the appointee shall assume the sequence of service established by his predecessor and shall receive a certificate stating his actual service in the hospital.

* * * * * *

In order to illustrate the manner in which this plan can be practically applied the following table is shown, in which the letters A. B. C. D. E. F. G. stand in place of the names of the members of the resident staff on duty during a period of two years. This will show the time each member spends in each position; it also indicates which member will succeed him when this period

of service is concluded. It also shows the amount of preliminary training each member has had before he acts in the capacity of senior house physician or surgeon.

This tabulation does not show the service of externes in a hospital of two hundred active beds.

TYPICAL ARRANGEMENT OF SCHEDULE FOR TWO YEARS' SERVICE.

A.—First Senior House Surgeon's Service, begins Jan. 1, 1906, ends July 1, 1906.

B.—Second Senior House Surgeon's Service, begins Jan. 1, 1906, ends July 1, 1906.

B.—Becomes First Senior House Surgeon July 1, 1906, service ends Jan. 1, 1907.

C.—Senior House Physician Service begins Jan. 1, 1906, service ends Jan. 1, 1907.

D.—Pathologist Service begins Jan. 1, 1906, ends April 1, 1906.

D.—Becomes Junior House Physician Apr. 1, 1906, service ends July 1, 1906.

D.—Becomes Junior House Surgeon, First Division, begins July 1, 1906, service ends Oct. 1, 1906.

D.—Becomes House Physician, First Division, begins Oct. 1, 1906, service ends Jan. 1, 1907.

D.—May become Senior House Physician, First Division, begins Jan. 1, 1907, service ends Jan. 1, 1908.

Or—

Second Senior House Surgeon, begins Jan. 1, 1907, service ends July 1, 1907.

First Senior House Surgeon, begins July 1, 1907, service ends Jan. 1, 1908.

E.—Junior House Physician, service begins Jan. 1, 1906, service ends Apr. 1, 1906.

E.—Becomes Junior House Surgeon, First Division, begins Apr. 1, 1906, service ends July 1, 1906.

E.—Becomes Special House Physician, begins July 1, 1906, service ends Oct. 1, 1906.

E.—Becomes Junior House Surgeon, Second Division, begins Oct. 1, 1906, service ends Jan. 1, 1907.

E.—May become—

Either Senior House Physician, begins Jan. 1, 1907, service ends Jan. 1, 1908.

Or Second Senior House Surgeon, begins Jan. 1, 1907, service ends July 1, 1907.

Or First Senior House Surgeon, begins July 1, 1907, service ends June 1, 1908.

F.—Junior House Surgeon, First Division, service begins Jan. 1, 1906, ends Apr. 1, 1906.

F.—Becomes Special House Physician, begins Apr. 1, 1906, ends July 1, 1906.

F.—Becomes Pathologist, service begins July 1, 1906, ends Oct. 1, 1906.

F.—Becomes Junior House Physician, service begins Oct. 1, 1906, ends Jan. 1, 1907.

G.—Special House Physician, service begins Jan. 1, 1906, ends Apr. 1, 1906.

G.—Becomes Pathologist, service begins Apr. 1, 1906, ends July 1, 1906.

G.—Becomes Junior House Physician, service begins July 1, 1906, ends Oct. 1, 1906.

G.—Becomes Junior House Surgeon, service begins Oct. 1, 1906, ends Jan. 1, 1907.

It is profitable to have, aside from this resident staff, an externe staff which is distributed according to the activity of the department: each resident having as his assistant one or two externes who serve directly under him and who have no responsibility in the care of patients, but should be present at operations, assist in dressings and in examinations, and make themselves useful in any way desired by the resident staff.

With a careful system of selection of the staff, and a reasonable arrangement of the work so that every member is fully occupied, there need be no occasion for the occurrence of difficulties in regulating the house staff. One trouble that is likely to come, however, is from the selection of internes through influence, and not through merit; the natural inference of the interne being that so long as it was not necessary to excel in quality in order to obtain the position, it is not necessary to excel in service in order to maintain his position.

The second source of trouble arises from giving internes too little work to do, for idleness will spoil the best internes.

A lack of regularity and punctuality on the part of members of the attending staff is also responsible for bad interne service in many instances. One frequently sees excellent internes in the department of one attending or surgeon, and very inferior service in the department of another member of the attending staff of the same institution, not because there is a difference in the inherent quality of internes, but because the member of the attending staff is incompetent in some particular.

The greatest source of difficulty in managing the resident staff at the present time in the majority of hospitals organized according to the plans most in vogue results from the fact that there are so many changes that no definite system can be developed at any given time before a change occurs in the head of the department.

In institutions in which the attending physician and surgeon do not have a continuous service, so that there are changes in each department every two to six months, the difference in the methods and in the personal peculiarities must always be sufficient to make it impossible for any one member of the staff to perfect even a reasonably fair system for his resident staff.

It might be claimed that the interruption of the service during the vacation of the chief would have the same effect in the system advocated above. This, however, is not the case, because the incumbent representing the chief during his vacation is a part of the latter's organization, and usually has had his early training under this chief.

In smaller institutions of fifty beds or less these conditions naturally become still less favorable, because here it will be possible to maintain only one resident physician or interne, and he must necessarily serve all of the various members of the visiting staff.

Usually the plan of securing a physician for this position who has served as junior resident or externe in some larger hospital, is more satisfactory than to take an assistant directly from some medical school, but unless he be a young man with unusual tact, the service is not likely to be very satisfactory.

Should there be in the visiting staff one person whose authority is recognized by all of the other members of the staff, and whose methods are followed by the entire staff, this member must not only have ability to arrange the service, but he must be willing to give a sufficient amount of time to its details to insure its full success. It is from this side of the organization of smaller hospitals that they suffer greatly in competition with the larger ones. On the other hand, this very fact has forced many physicians to pay special attention to the details of hospital management for these smaller institutions, which has resulted in the establishment of many splendidly organized small hospitals in various parts of the country.

Where the hospital is still smaller the difficulty in question is overcome in another manner. Instead of employing a resident physician, the duties which are ordinarily performed by this officer are left in the hands of the superintendent of nurses. With care it is always possible to secure a trained nurse with great execu-

tive ability, good judgment and extensive experience, who can perform these duties to the advantage of the institution, so that the service is vastly better than it would be under the care of a young graduate in medicine.

There are more of the successful small hospitals in this country that owe their usefulness and prosperity to the energy, tact and judgment of a carefully selected superintendent of nurses, than to any other one factor in their organization. It is of the greatest importance that this fact be borne in mind.

GRADED STAFF FOR MUNICIPAL HOSPITALS.

In the organization of large municipal hospitals there are two chief perils. The first of these results from a selection of entirely unfit men simply through political influence. The second follows from selecting men whose standing is sufficiently high when they enter upon their duties to warrant their appointment, but who fail to progress because they are secure in their appointment and the element of competition is eliminated from their sphere, and without this stimulant they soon fall behind.

In this manner it frequently happens that the development of an institution is greatly hampered because the principles upon which the organization is planned do not include the elements of progress.

This fault can be corrected in several ways. First, by an age limit, which has been referred to; second, by a service which is restricted to a given number of years; and third, by the adoption of a graded system which will constantly introduce young men of unusual ability, training, industry, energy and enthusiasm.

This graded system will make it impossible for incompetent novices to utilize the patients of the institution for clinical material for their own advancement without regard to the interests of the patients. They will have gained great experience as assistants before they are placed in responsible positions, and before serious cases have to depend upon their unaided judgment for decisions of vital importance. It will be worth their while to labor diligently and patiently in gaining skill and learning, because the system must lead ultimately to a responsible position for he who is willing to spend his time and energy in this manner, and because with a service that is limited in all its periods vacancies in the higher positions are bound to occur.

It seems well to divide this service into five periods of six years each, as follows: The first period should be composed of two parts of three years each; the first three years should be spent in the capacity of externe, junior house physician or sur-

geon or both, and as senior house physician or surgeon, or both; the second three years should be largely spent in scientific or research work either at home or abroad, or both, and service in the capacity of chief clinical assistant to the chief of a department or to a visiting physician or surgeon.

The second period of six years should be spent as junior attending physician or surgeon, and in the service of attending physician or surgeon to the outdoor or dispensary department. Much time should be spent in diagnosis, and research work should be continued.

The third period of six years should be given as attending or visiting physician or surgeon, having charge of certain wards under the direction of the chief of the department.

The fourth period of six years should be occupied as chief of a department in full control of entire division of the hospital. It is possible that this period should be twice as long as each of the other periods, in order to make it worth while to spend years of hard labor for the purpose of achieving this position, and in order to provide a sufficiently long service to enable an incumbent to complete extensive plans of development.

In order to secure the best results in this class of institutions, there can be no doubt that the period of this service should be definitely fixed.

The fifth period should be indefinite. The incumbent should be eligible to this position only after completing the fourth period. This office should carry no responsibilities and no duties. It should, however, contain all the privileges of all the other members of the staff, all of whom having the right to request, but not to demand, the advice of any member of the consulting staff.

In smaller cities not exceeding twenty-five thousand inhabitants the question of organizing a hospital staff is especially difficult.

It is equally difficult to lay down rules, because an examination of existing conditions shows that wherever these institutions have been successful, the success could be attributed to the fact that the institution contained one physician or surgeon of unusual qualifications. These qualifications may be largely personal, without unusual skill or learning, or there may be a rare combination of several of the important requisites, such as attractive personality, reliability, judgment, tact, energy, industry, perseverance, patience, and hopefulness, together with learning, experience and professional skill.

It is doubtful whether it will be possible to formulate a system which can be applied to the circumstances existing in most of the

smaller towns, but for the present the following two plans have afforded the best results:

The first plan has been adopted in many of the hospitals conducted by the sisterhoods.

The hospital is open to any reputable physician so long as he does not use his influence to oppose the interests of the institution. This has the advantage of leaving the government of the institution entirely in the hands of a person who has an opportunity to study hospital management, and one whose whole interest is directed toward the advancement of the institution. This person is the sister-in-charge of the hospital. She soon learns from observation which physicians or surgeons in the city are thoroughly interested in hospital work, and then she can go to such for advice.

A further advantage of affording every practitioner in the city an opportunity to treat any patient he desires in the hospital without regard to specialties, is allowed.

The disadvantage in this system comes from the fact that it does not provide for a reasonable working machine from the standpoint of the medical department, and although the results are usually fairly good, they can never attain any real excellence.

The second plan implies a division into the various specialties. In very small hospitals the entire field may be divided into medical and surgical.

Whatever the number of specialties may be, each member of the staff must confine his activity within the hospital to his specialty, and he must also spend a reasonable amount of time each year in post-graduate work for the purpose of becoming more expert in his special department.

Aside from this difference, the organization of the medical staff should be the same as in case of larger hospitals conducted by hospital societies.

It may be well to limit the executive or attending staff to one person for each specialty, and to appoint all of the other physicians in the city who are willing to be active in the development of the institution to the visiting staff, with the same privileges, but with the omission of executive duties.

This course is likely to be beneficial to the institution by obtaining the support of the entire local medical profession.

CHAPTER VII.

ORGANIZATION OF TRAINING SCHOOLS.

The first and most important point to be considered in connection with the organization of training schools for nurses is to secure a proper person for the head of this department. While it is often difficult to accomplish this object, yet in this country it is always possible. If all irrelevant conditions are ignored, and a person is chosen because she possesses the necessary personal qualities, the necessary education and experience, the patience, perseverance, reliability, industry and executive ability required for the position, and above all an unlimited amount of enthusiasm for her work, then the first and most important step has been taken. In many instances other qualifications are placed first, and the requisites mentioned above are placed only in a secondary position.

When a person is chosen because of her religious denominational convictions, nationality or because of some social qualification, the result is nothing short of a calamity, as it virtually eliminates the element of competition through merit.

In selecting a person to fill the position of Superintendent of Nurses, it is important to place much value upon actual experience. It is far better to choose a nurse who has acted as superintendent in a training school in a small hospital, or as assistant superintendent in a large one, or as head nurse of a floor, pavilion or department in a large hospital, than to select a recent graduate, however brilliant her attainments may be, who has not had any actual experience in a similar capacity. It is the actual experience which enables a Superintendent of Nurses to determine what can be accomplished with existing conditions in the institution to which she may be called (for the purpose of acting as superintendent of the training school).

Taking it for granted that a person with the proper qualifications has been chosen, the department should be entirely under her direction. She should arrange the course of study, the number of lectures, recitations and examinations. She should pass upon qualifications for admission, and should have power to dismiss pupil nurses for any reason that might seem proper to her.

In case the service of a nurse is unsatisfactory to the mem-

bers of the staff, their criticism should be made to the Superintendent of the Training School, whose duty it would be to devise means to make the nursing satisfactory.

In hospitals of more than fifty beds an Assistant Superintendent of Nurses should be employed, who should be chosen by the Superintendent of Nurses and appointed by the Board of Trustees. In hospitals of more than one hundred and fifty beds, there should always be a night superintendent of nurses, who should also be chosen by the Superintendent of Nurses, and appointed by the Board of Trustees.

TRAINING OF NURSES.

In order that the training may be efficient and the services of the nurse at the same time satisfactory to the hospital, it is important that the Superintendent of Nurses be in constant contact with her pupil nurses throughout the entire term of service. It is impossible to give nurses proper training in the classroom alone, or by an occasional tour of inspection through the hospital. The scientific teaching by means of lectures must be supplemented every day and all day by friendly assistance at the bedside. The training given to nurses should so develop women with the necessary qualities as to enable them to care for the sick properly, not only in the hospital, but also in private families; consequently a nurse must acquire many qualities outside of those necessary to enable her to perform the technical work connected with her profession.

The Superintendent should be with her pupil nurses at the nurses' home, in the dining room, at their recreation, and should use her influence and enthusiasm to direct and further their development.

It is important that there be no friction in the management of the training school. This can be accomplished if the nurses learn from experience that merit alone counts, and that the authority of their Superintendent is absolute, and at the same time just and competent. It is necessary to teach the pupil nurse by example, not precept. There must be concentration in all the work done, whether this be in study or in bedside nursing. This affects the success of the institution enormously. The result in the training of the individual nurse is of the very greatest value.

It is doubtful if there is much to be gained by making the course ultra-scientific in its tendency. In a general way a nurse with good judgment cannot have too much learning unless it be acquired at the expense of practical knowledge. The nurse's service in the hospital during her term as pupil nurse must nec-

essarily be largely practical, and it is what she actually does for the patient that most benefits the institution as well as herself. In payment for this service to the institution she receives her scientific training. After graduation her services in the capacity of private nurse are practical in character; it is consequently important that this side of her training should receive careful attention.

The conduct of a training school in a hospital has the immediate object of furnishing the institutiton with competent nursing within the means of the institution. Remotely the character of the nurses graduated affects the institution to a great extent, because these nurses reflect the quality of their training during their work as private nurses in the families of people whose interest is valuable to the institution.

In some of the smaller cities it seems proper for the hospital to furnish a certain number of pupil nurses for service in families whose financial condition prevents them from employing trained or graduate nurses. But there is a possibility of abuse in this direction, and it is never well to make a commercial institution out of a training school for nurses. In larger cities where the visiting nurses associations are established, it is probably best to prohibit under-graduate nurses from doing private nursing while they are still in training in the hospital.

SIZE OF HOSPITALS REQUIRING TRAINING SCHOOLS.

At the present time there is a tendency to oppose the establishment of training schools in small hospitals. The training is undoubtedly not so varied in these smaller institutions, where only a limited variety of diseases are treated. The nursing of surgical patients usually predominates, there are but few medical cases and no obstetrical patients. After graduation, however, these two varieties of patients furnish almost the entire work for the graduate trained nurse. From an educational standpoint there are objections against the training of nurses in these smaller hospitals, but the deficiency in training can be supplemented after graduation by the members of the staff, who usually employ these nurses in their private practice, which is largely composed of obstetrical and medical cases. In a general way a competent surgical nurse can easily be changed into a safe and efficient obstetrical nurse, consequently, viewed from its practical side, there seems to be no serious objection against the establishment of training schools in small hospitals.

The real objections to this plan are, first, that it is difficult to obtain for the position of Superintendent in a small institution

a nurse competent to conduct a training school; and, second, that members of the staff so often do not appreciate the importance of being systematic in their lectures to the nurses. In order to avoid this last difficulty the Superintendent of Nurses should arrange a schedule of lectures to be given at different hours on different days of the week. Each member of the teaching staff should also be a member of the medical staff of the hospital. He should have assigned to him a definite hour on definite days, upon a regular schedule. In smaller towns it is difficult for members of the staff to be free at a given time, because of the emergencies that occur in the professional life of these practitioners. In order to avoid a part of this difficulty in the management of the curriculum of the training school, the following plan has been employed: The members of the teaching staff arrange a syllabus of each lecture upon a card before the beginning of the term of instruction. At each lesson they may enlarge or supplant this syllabus, but they must have an outline of the entire course completed at the beginning of the school year. This card system must be so arranged that each lecture is a unit in itself.

The Superintendent of Nurses has a list of the teachers on duty, and in case one of these teachers is prevented from filling his hour as per schedule, he should notify the Superintendent of Nurses of this fact and she in turn should communicate with the next member of the staff on her list and secure his services for this hour. If he should also find it impossible to fill the hour, each successive member of the teaching staff is communicated with until one that is available is found. Having previously arranged the outline for his lecture, it will be possible for him to fill the hour without special preparation, and without detriment to the course. It is exceedingly harmful to the discipline of a class to dismiss it because a teacher fails to fill an hour according to schedule. In case a member of the staff fails repeatedly to keep his teaching engagements, another of the staff should be permanently substituted in his place.

Another difficulty in connection with the didactic instruction of nurses comes from the fact that they are occasionally prevented from appearing in class because of some emergency that keeps them with the patients. In order not to let this element discourage the pupil nurse, the teacher should briefly review the substance of the previous lecture. It is also well to have the pupil nurses work in pairs, each one taking careful notes of the lecture and supplying these notes to the classmate who happens to be detained by her duties from attending the lecture.

It is important, however, to state here that with proper plan-

ning on the part of the Superintendent of Nurses, it will be almost always possible for the nurses to be present at every lecture. In order to accomplish this the Superintendent must keep an accurate list of nurses belonging to the various classes which meet at a definite hour on different days of the week. Every morning in giving the special orders of service for the day, the Superintendent of Nurses, or her assistant, should assign substitute duty for the nurse who cannot leave her work for the hour in question. It will be necessary to keep a number of relief nurses for this purpose, which will vary according to the severity of the cases under treatment in the hospital. The service is improved so greatly by the introduction of this element that the additional expense of providing these relief nurses is of no importance. To allow frequent absence from class work speaks of incompetence or carelessness on the part of the head of the training school.

ADMISSION OF PUPILS TO THE TRAINING SCHOOL.

Until recently most training schools accepted pupils at any time during the year under the supposition that it would not be well to have a large proportion of the nurses leave the hospital at one time, and consequently their places taken by new nurses, or "beginners." It seems, however, that this supposition is not borne out by recent experience. By receiving all of the pupil nurses for a given year at the same time, or by receiving one-half of the number at one time and the other half six months later, it is possible to train all of these nurses in the elements of their profession uniformly. It is true that this imposes an additional burden on the older nurses for a time, but this is counteracted by the fact that all the pupils progress more uniformly in their theoretical and practical education than they would if the training school contained pupils in all stages of development; furthermore, each nurse will receive the benefit of every detail in the training.

QUALIFICATIONS FOR ADMISSION.

There must necessarily be an educational qualification, which will vary with the location of the training school. The pupil nurse must have a sufficient amount of preliminary education to be able to comprehend the various studies contained in the curriculum. Ordinarily it is probably best to require the equivalent of an ordinary high school education. The applicant should be physically strong in order to perform the arduous tasks required of her. She should be at least twenty years of age, and under thirty-five years; she should possess kindliness and refinement, and she should be fully imbued with the seriousness of her purpose and of her work.

Possessing these qualities, it seems unnecessary to add that she must be *honest*. Lacking in honesty, she would be absolutely disqualified for this work.

TERM OF SERVICE FOR NURSES.

As regards the length of the course great injustice can be done by retaining the nurse three years, practically offering the third year what was given during the first. In the larger hospitals having departments of internal medicine, surgery and obstetrics, as well as various minor departments, it is probably best to have the term of service for nurses three years. In the smaller hospitals it is better to have the service two years, the nurse then taking a post-graduate course of one year.

ARRANGEMENT OF INSTRUCTION.

The course should always be graded, a definite service being outlined for each class.

The laboratory instructions, lectures on medical diseases, surgical technique and obstetrics are given by the medical staff, while the other instruction is given by the Superintendent and her assistants.

The junior nurses are given the general ward duties; the intermediate class receive the laboratory, diet-kitchen and special duty service; the senior class is given the operating room, the obstetrical, and head nurse service. During the first months clinical demonstrations are given to probationers in sections of eight or ten. A uniformity in method is thus at once established, and an opportunity afforded the instructor to judge of the pupil's adaptability.

SUBJECTS.

First Clinic—

- Introductory talks on the cause and danger of infection.
- Disinfection.
- Care of all bedside utensils with disinfection and sterilization.
- Care of the lavatory.
- Care of typhoid excreta.
- Care of soiled linen.

Second Clinic—

- Care of beds; iron, brass, folding.
- Care of mattresses—hair, straw, water, air.
- Care and protection of pillows, bed covers.
- Cleaning of bedsteads and mattresses—renovating.
- Prevention and extermination of vermin.

Making beds for convalescents.
Making beds for bed patients.
Making beds for operation cases.

Third Clinic—

Care of bed patients.
Baths.
Cleansing.
Shampooing.
Changing position.
Changing clothing.
Lifting.
Appliances, pads, rings, cradles, hot bags, bottles, bricks, head rests, foot rests.

Fourth Clinic—

Pulse.
Temperature.
Respiration in health and disease.
Care of the mouth.
Care of the hands.
Care of the back.
Feeding helpless patients.

Fifth Clinic—

Sponging.
Packing.
Tubbing.
Ice bags, caps and coils.
Cold compresses.
Medicated baths.
Hot air baths.
Calomel fumigations.

Sixth Clinic—

Fomentations and turpentine stupes.
Poultices.
Plasters.
Blisters.
Counter-irritants.
Cupping.
Leaches.
Antiphlogistics.

Seventh Clinic—

Sterilization.
Hands—instruments.
Dressings.
Surgical supplies for bedside dressings.

Eighth Clinic—

Enemata—nutritive, sedative, stimulating, laxative.
Catheterization.
Douches—vaginal and vesical.

Ninth Clinic—

Gastric lavage.
Nasal feeding.
Hypodermoclysis.
Hypodermic injection.

Tenth Clinic—

Charting.
Recording.
Procuring specimens—urine, feces, stomach contents.
Preparation of patient for an operation.

Eleventh Clinic—

Bandaging.
Fractures.
Fracture beds.
Improvising splints—stretchers.
Gynecological positions.
Local applications.

Twelfth Clinic—

Medicines.
Weights and measures.
Correct labeling.
Care in dispensing.
Methods of administration.
Making of solutions.
Giving oxygen.

Simultaneously with the nursing clinics, these instructions in nursing ethics and etiquette are given:

Nursing Ethics—

Nursing history.
Qualifications.
The spirit of nursing.
Discipline.
Health.
Study.
Economy.
Courtesy, sympathy.
Uniform.
The patient, the doctor, the friends.
Ward duty.

Night duty.
Special duty.
Administrative duties.
The graduate nurse.

Junior Year—
Elementary physiology.
Bacteriology.
Hygiene.
Elementary materia medica.
Medical diseases.
Cooking classes.

Intermediate Year—
Physiology and anatomy.
Advanced materia medica.
Dietetics.
Urinalysis.
Anesthetics.
Surgical technique.
Gynecology.

Senior Year—
Obstetrics.
Pediatrics.
Private duty.
Training school executive work.
Parliamentary law.
Preparation for Alumnæ Association.
Discussions of nursing journal articles.

NUMBER OF NURSES.

The character of the medical and surgical work in each hospital will determine the number of nurses required. If there are many cases of chronic diseases treated in the hospital one nurse will probably suffice for every five patients. If the service is limited to acute cases, it will require at least one nurse for every three beds. In children's hospitals where only acute cases are taken, it will require one nurse for every four beds; if chronic cases predominate, one nurse for six or eight beds will be sufficient.

GRADUATE NURSES IN HOSPITALS.

In the large institutions it has been found advantageous to employ a number of recently graduated nurses for the most important positions—for head nurse of the operating room, and for a nurse in charge of each of the various pavilions or floors in the

many-storied hospitals. In hospitals which are divided into departments, with a member of the medical staff at the head of each department, it is best to have a graduate head nurse for each department, so that this nurse can be directly responsible to the head of the medical staff, being at the same time under the supervision of the Superintendent and Assistant Superintendent of Nurses.

A number of small institutions have attempted to secure unusually excellent nursing by employing only graduate nurses. If this is done according to a definite system which establishes the nursing department of the private hospital as a post-graduate training school for the care of private patients, it may be fairly satisfactory, providing the course continues for a period of at least six months, and is under the rigorous supervision of a head nurse of superior qualifications. If, however, each nurse is employed for the individual case that is under treatment, the result will be most unsatisfactory, as it will be impossible to establish discipline. These nurses cannot be all taken from one school, consequently there can be no uniformity in their service. During the short period they are employed in the hospital they cannot become familiar with the system preferred by the Superintendent in charge. Were it possible to employ graduate nurses, and to keep each of these nurses for six months, or a year, or longer, it would still be doubtful whether the nursing as a whole would be as satisfactory as it is in institutions supplied with under-graduate nurses. The service requiring special skill can be carried out by those who have been in training sufficiently long to be perfectly competent, and the remaining service can be accomplished by those less thoroughly trained if there is careful supervision of their work. The earnest, constant endeavor and the enthusiasm one finds among under-graduate nurses adds much to the value of their services, and is a strong element in favor of the training schools, in preference to the work done by post-graduate nurses.

THE CONSTRUCTION OF HOSPITALS.

INTRODUCTION.

The ever increasing demand for hospitals has given rise to a problem the solution of which is of serious and vital importance, and which up to the present time has been neither definitely nor comprehensively determined. More than in any other class of building the hospital architect, the expert in this particular and specific branch of architecture, realizes that in his work he must anticipate progress. Most hospitals are built too quickly, and therefore imperfectly, and in consequence the present only is considered, without serious thought for the future. The architect is too often dominated by the hospital committee in the matter of size and expenditure, irrespective of the relative bearing of one upon the other. In its eagerness to complete a structure, a committee will often voluntarily sacrifice the best and accept an imperfect plan. Instead of slowly and carefully perfecting a good plan, which should be carried out as circumstances permit, it deliberately foregoes what it knows is ideal. In this the committee is not the only transgressor as the architect should not permit himself to be a party to any such proceeding.

One well-planned, perfectly built hospital is more to be desired than many that have been conceived with the predominant thought of a building to serve a purpose, and in which there has been no provision whatever for the future.

The hospital architect of to-day must exercise care in designing his building along lines not as the committee wishes it to be planned, but rather along those which will give to it what is really needed for its future development.

Hospital architecture is only in its infancy. The evolution has but begun; modern appliances and methods of construction; the application of aseptic principles; the multitude of ever-increasing methods, must be closely followed and used intelligently to the end that all hospitals shall be the best to serve their purpose now and in the future.

CHAPTER VIII.

GENERAL CONSTRUCTION.

It will not be necessary to go into the detail of construction of buildings of this character, as the general rules and specifications which are employed in the erection of any building would apply here also. It will, however, be necessary to go into detail regarding special materials that are better adapted for hospitals than any other material would be for this purpose.

There is probably no class of building for which a responsible contractor is so necessary as in hospitals, as so much depends upon the sanitary condition of the building itself. It must be well erected in all its essential parts in order that everything may fit properly, and that there shall be no cause whatever for extraordinary effort in keeping the institution in a good condition. This particularly applies to interior construction.

Another point to be taken into consideration is the fact that irresponsible contractors are frequently given the work because they have underbid some responsible man, or because some favoritism is shown. Often the committee or some inexperienced member superintends the work without consulting the architect. Consequently there are serious defects, which make the difference between a good piece of work and one which is imperfect.

The specifying of material should be left to the expert (the architect who specializes on hospital work), for he keeps in touch with the newest and best improvements and is qualified to determine what should be used. All matters pertaining to the construction of the building should be referred to the architect. No changes should be sanctioned or permitted by any one except upon written order of the architect. There is no more potent factor for dissention and consequent errors than the promiscuous orders of members of committees to permit changes and substitution of material; once this is begun the contractors set at naught all orders of the architect and there immediately arise the defects mentioned.

In the designing of buildings for hospital purposes the one essential feature always to be kept in mind is that the best results are to be obtained, namely:

The maximum of efficiency at a minimum cost. A building of

this character should under no circumstances whatever be a monument to either the committee which is in charge of the building nor to the architect who is doing the work. A specialist appreciates this, for he well knows that a sightly and well constructed building can be erected at a cost which will make a decided saving over the more ornamental design, and that this difference in cost will often pay for the entire equipment of the institution.

The architect must differentiate between construction as *essential* and as *accessory* in erecting buildings of this character. By essential, is meant those things which are absolutely necessary in the construction of the building. By accessory is meant such things as are not necessarily structural, but which still make a difference between a complete, well constructed institution and one in which small faults are evident. As an example of this principle are the partitions which make the stair well and elevator shaft fireproof and isolated. Attention may also be called to the fact that while wooden window sills might fulfill all requirements as an accessory, they are still not necessary as an essential, for a splay can be put at the sill and do away entirely with the ordinary flat sill; but as an accessory the wooden sill is not the best material that can be used for very obvious reasons, such as their destructibility, the necessity for keeping them painted and varnished to prevent their discoloration and deterioration; sills of marble, slate, or even of glass while still accessory are highly essential.

As stated elsewhere, it is not the object of the authors to offer general suggestions for the construction of hospitals, as this is obviously the province of the supervising architect, or the local architect as the case may be. Nor are the suggestions made here to be considered as being the outline of specifications, for it will be necessary to treat the topic heads in different specifications in exact manner, not only generally but to fit local conditions. The salient features, those necessary in hospital construction, are set forth as to the best possible method of treating the various parts of the work. It will be found that there are many items herein omitted, which the architect, in making his specifications, will undoubtedly be able to supply, as they are standard in all classes of buildings and in many cases are fundamental.

A hospital building must be constructed properly. If there are not sufficient funds at hand to do this, the entire project should be delayed until there are, or until it is assured that money will be forthcoming. The plans should be thoughtfully and carefully considered, so that the money at hand can be employed to the best advantage. It is not necessary primarily to have a given amount of money to produce a desired result. It is far better to have

plans drawn and thoroughly discussed, and all of the details left in the hands of an expert and gone over with the committee before the building is started. The initial expense of plans and specifications is nil where time is concerned. The only loss after the building is started is in the structure advancing slowly; when once started, it should be carried to its completion as quickly as possible without changes of any sort, and this is possible only when the plans and specifications are complete in every detail. The employment of an architect who has had experience and is conversant with these details of hospital construction is the logical means to such an end.

In the construction of hospitals what is absolutely essential for the stability and protection of the building, as well as for the safety of the contents and occupants, is too often proscribed owing to the short-sighted views of economy. That fireproof construction is to-day one of the most valuable assets in building cannot be denied. If we consider, as we should, that hospitals are built for all time, a small increase of expenditure at the beginning should not stand in the way. It would be better policy to curtail cost in other directions rather than to cut down on so vital a point as fireproofing. A building so constructed, even with the plainest exterior and simpler interior finish, is vastly preferable to one with an ornate front and interior construction, which, at best, would not be permanent and which could be so easily destroyed.

It is the duty of the architect, therefore, first and foremost, to insist upon thorough fireproof construction. When one considers that the actual difference in cost between a so-called slow-burning mill construction and a fireproof building is ten per cent. in the heaviest and largest building, and that in hospitals this rarely exceeds five per cent., it needs no great amount of argument in favor of the latter form of construction. Added to this is the moral obligation on the part of the hospital authorities to safeguard, by all possible means, the lives of the patients. As hospitals are essentially erected for the saving of lives, every possible means at hand must be employed to this end, and the safeguarding of those who are helpless, by placing them in buildings which are immune from fire, should not be the least or last of these precautions. On the contrary, it is the first requisite that the construction of the hospital should be absolutely fireproof in every detail.

It is the intention to give herein, as concisely as possible, what is essential under given circumstances, how this can best be procured, and how the maximum results in both the matter of building and the running of the institution after being built can be ob-

tained. Under separate headings the essentials of good construction for modern hospitals will be given in detail, especially those points which are at present unobtainable, except through very tedious and more or less dubious channels, for the use of the individual or committee building a hospital.

The modern methods of fireproofing, and the general construction of buildings necessitated by this, will be found under a separate head.

It must be borne in mind at all times that superfluous ornament bears no organic relation to the hospital itself. Esthetics may have great influence upon the design of a building of this character. The exterior of a building may be made to serve as a monument to the man who furnished the funds; to the architect who has highly esthetic ideas and a lack of practical application to the real problems confronting him, but to the average man interested in this problem it is evident that the best working results obtainable must be procured for the money in hand.

Dr. Goldwater says "The hospital of 1870—I mean the average hospital—was built at a cost of about fifteen cents per cubic foot. The exterior was simple; the plumbing and heating were of a kind now considered rudimentary; the building was not fireproof, and was finished with wood and with plaster on lath. Such a hospital could be duplicated in New York to-day, if the building laws allowed, at a cost of twenty cents a cubic foot. Allowing for all purposes six thousand cubic feet per patient (an unusually liberal allowance for 1870), the cost of a hospital of 450 beds or 2,700,000 cubic feet would be $540,000, or $1,200 per bed.

"Now compare with this the most recently constructed general hospital in New York City, a hospital built to accommodate four hundred and fifty patients. This building or group of buildings at the prevailing market rates for construction would cost forty cents per cubic foot. (The actual cost was nearer thirty-five cents per foot, but the contract was made at a moment favorable for the hospital and could hardly be duplicated to-day.) If the old space allowance prevailed—namely, six thousand cubic feet per patient—a modern hospital of four hundred and fifty beds would cost just double the price of brick and wood hospital of the kind I have described—that is, $2,400 per bed instead of $1,200.

"*Cost of foreign hospitals.* It may add to the interest of the argument, but it will not help much, to compare with these figures the costs of certain typical foreign hospitals, some of them not so recently built, but all ranking as modern. In Germany under quite different economic conditions and with a simpler type of construction, costs have been relatively low. The Hamburg-Ep-

pendorf Krankenhaus, built nearly twenty years ago for 1,500 patients, cost 3,480 marks, or $870 per bed; the Municipal Hospital in Berlin, known as the Urban Krankenhaus, which accommodates six hundred patients, cost $1,075 per bed, and 'Friedrichshain,' under the same management, cost $1,500 per bed. To turn to France, it may be noticed that the Larisboisiere, Fig. 294, a monumental pavilion hospital built in Paris about sixty years ago and accommodating about six hundred patients, cost $3,250 per bed.

"St. Thomas' Hospital in London has accommodations for 558 patients, and its cost of construction was about the same. The costliest hospital in London is the Belgrave Hospital for children, built for seventy-eight patients at a cost of $3,500 per bed. The Royal Victoria, at Belfast, on the other hand, presents an example of a recently constructed hospital, embracing seventeen large wards and costing only $1,500 per bed."

One of the leading physicians and a superintendent of one of the largest hospitals in New York recently stated that in the analysis of increased cost he takes as the units which have contributed to this cost the difference in material; the greater space allowance per patient; protection against fire—that is, the substitution of fireproof instead of inflammable building materials; the introduction of complicated heating and ventilating plants; automatic heat regulation; the use of electric light and power; the water supply; the equipment of laundry, refrigeration, kitchens and diet kitchens; the ward unity; the introduction of dressing rooms, anesthetizing rooms, sterilizing rooms, etc., with the surgical department; the matter of disinfection and sterilization; the consulting rooms; the housing of the house staff; taking care of the nursing force, and the accommodation of the minor employes; the introduction of special departments, such as the X-ray department and hydrotherapeutic department; the use in some hospitals of the outdoor department—the isolation wards and the branch hospitals for convalescents; all of which subjects will be treated separately under their respective heads, but are mentioned here to show some of the items that are responsible for the increased cost of hospital construction.

CHAPTER IX.

LOCATION OF HOSPITALS.

The location of a hospital should be chosen in order to secure the following conditions:

First—An abundance of sunlight.

Second—Absence of noise.

Third—Absence of dust.

Fourth—Absence of smoke.

Fifth—Proper ventilation.

Sixth—Disposition of sewage.

Seventh—Safety from fire.

Eighth—Possibility of future expansion.

Ninth—Accessibility for patients, their friends and for the medical staff.

Investigation regarding the location of existing hospitals will show that in most instances they were not chosen because of the above considerations. Ordinarily it will be found that the hospital location is chosen because it is cheap; because some philanthropic person has donated it to the committee; because some influential member wishes to dispose of a particular piece of property; because it is in the vicinity of some medical college; or because some selfish member of the medical staff desires the hospital convenient to his residence; and only rarely because it is especially suited for a hospital site.

There are certain fundamental principles which should be borne in mind in the selection of a site for a hospital, no matter whether it be located in a great city or a country town. Of course all conditions are only relative. It is but rarely possible to obtain the ideal conditions in the selection of a site, which have indeed been practically obtained in a few instances, one particular example being that of the Royal Victoria Hospital, in Montreal; but it is possible in every city or town to approximate these conditions much more closely than has been done in 90 per cent of all hospitals. It should be stated here that this criticism applies, to a less extent, to the institutions conducted by sisterhoods than any others, because their selection of sites has in many cases been based upon the following principles.

ABUNDANCE OF SUNLIGHT.

It is so extremely simple to plan a building so that every room and ward will have sunlight during some portion of the day that it is surprising to find many hospital buildings in which one-third or more of the rooms never have a ray of sunlight.

In order to have sunlight in each room and ward it is necessary only to construct all buildings or pavilions from north to

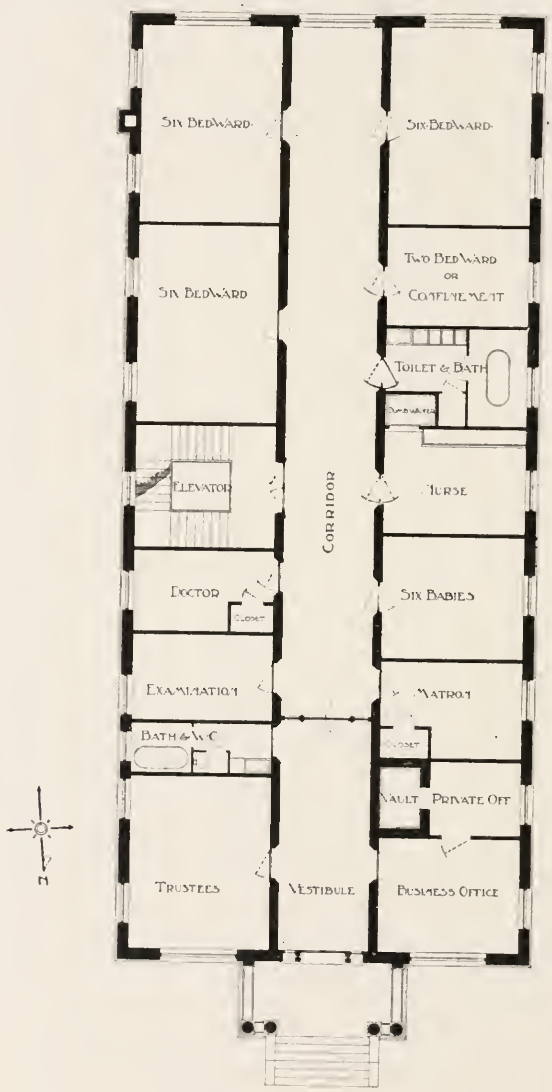


FIG. 1.
Meyer J. Sturm, Architect.

south, which will give one long side sunlight in the morning and the other side in the afternoon.

The importance of sunlight, its distribution, the production and depth of shadows, together with the bearing this subject has

upon the planning of hospitals, has been studied and illustrated with great care by Wm. Atkinson, architect. The author has kindly consented to permit the use of his article, and as it has been

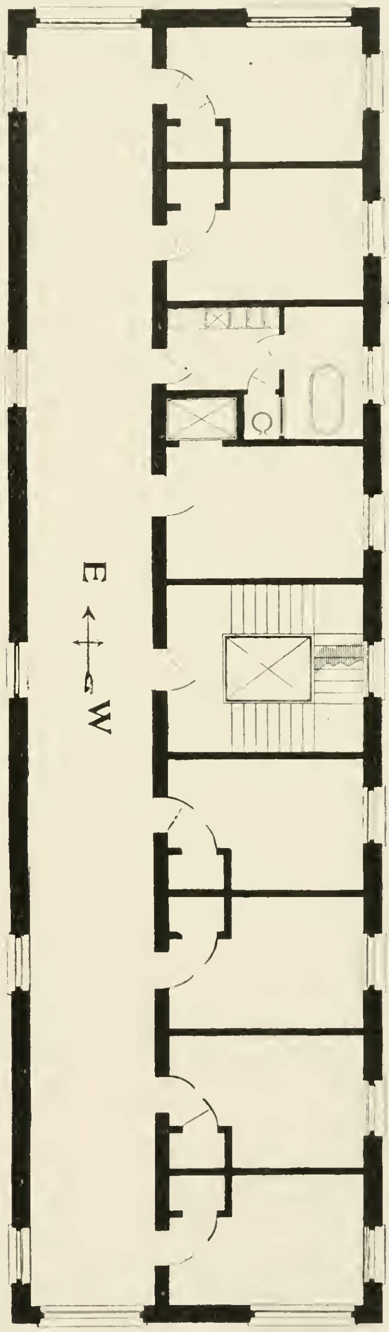


FIG. 2.

found impossible to improve upon it, it will be inserted in full in connection with the discussion of ground plans. The various shapes of wings have been thoroughly discussed in this article with

a careful consideration of the amount of sunlight and shadow obtained by buildings of the various forms usually employed.

At this point it may be well to direct attention to the fact that in long wings with a central hall, with wards or rooms arranged on either side of the hall, two outside and two inside walls, will house as many patients as four outside and two inside walls would were the wards or rooms arranged alongside one outside wall and a hall placed along the other outside wall and separated from the wards or rooms by an inside wall. This is plainly illustrated in Figs. 1 and 2, which represent two typical plans: Fig. 1 represents a hospital extending from north to south in which every room or ward is exposed to sunlight either in the forenoon or afternoon and the hall during midday; Fig. 2 represents a building extending from east to west with all of the rooms and wards exposed to the sun from the south and with a hall extending along the northern wall.

It is plain that the expense of constructing a hospital for a given number of beds must be at least 60 per cent. greater if plan Fig. 2 is followed than with plan Fig. 1, because the additional walls amount to 50 per cent, and there will be required double the amount of outside walls which are, of course, much more expensive. Moreover the same area of hall space serves twice the number of beds in Fig. 1 that it serves in Fig. 2.

But this is not all; the distance of travel required by those employed in caring for the sick is just doubled. The area of the hall which must be kept clean is twice as great. The number of windows which must be kept clean is approximately twice as great.

Aside from this there is the disadvantage in plan 2 from the fact that twice the surface of outside wall is exposed to the weather and twice the amount of hall space must be heated.

Against this we have the fact that in plan Fig. 2 every room is exposed to the south. In most climates it is likely that exposure to sunlight for half the day is equally satisfactory in all except the summer season, and to be preferred in this season.

It seems plain consequently that plan Fig. 1 is much to be preferred.

ABSENCE OF NOISE.

The site should be in a quiet portion of the city or town, away from noisy railroad tracks, street cars or elevated railroads, or noisy factories. In country towns this can be accomplished easily, and in great cities the location can be chosen at least three blocks away from ordinary railroad tracks.

(Nine-tenths of all of the larger hospitals in most of the American cities are located directly upon one or two street car tracks or within two blocks of an ordinary railroad track.)

ABSENCE OF DUST.

The location should be so chosen as to reduce exposure to street dust to a minimum. This can best be accomplished by selecting a high knoll in a hilly town, or by setting the building back from the street a considerable distance in a flat city and planting trees and shrubs which will act as natural filters along the edge of the grounds along the streets, and by erecting high buildings. Very little street dust, relatively, rises above the second story, so that the higher stories are nearly free from this contamination. In every city there are streets which are comparatively little used. This fact should be considered in the selection of a hospital site.

FREEDOM FROM SMOKE.

In many of our great cities there are locations in which there is but rarely any sunshine because of the presence of coal smoke from large furnaces and factories. These locations should of course be avoided in selecting hospital sites.

It is well to note the general direction of winds and to bear in mind the fact that smoke, although very diffusible in the air, will not be distributed to any considerable extent against even the slightest current in the air. It is also important to bear in mind that when the air is apparently still it nevertheless travels at a rate of about one hundred feet per minute, or about as one would move in sauntering along the street, taking a step in two seconds.

Again, in protecting the institution against smoke from any given source one can obtain a fair idea of the entire amount that will be delivered to an institution in still air by taking the distance from that source as the radius of a circle of which the segment corresponding to the length of the institution indicates the relative proportion of the smoke carried to this distance which will be delivered to the institution.

This illustration is employed to show how little of the entire volume of smoke will be delivered in still air to any given space which may be occupied by the hospital; and if the location is wisely chosen with this point in view it is usually possible to have the hospital on the windward side of the sources of especially great smoke producers during the prevailing winds, and thus the smoke nuisance will not be so much of an annoyance as one might expect. Fortunately smoke is usually produced in certain centers, and these centers can be avoided to a very considerable extent by the careful selection of the site.

VENTILATION.

It is plain that the location of a building will affect the conditions of ventilation to a very marked extent and that buildings lo-

cated upon an elevation will be constantly exposed to a more rapid current of air than they would be were they situated at a low point, especially if the low point is surrounded by other high buildings. Locating on the high points would favor natural ventilation, and in case forced ventilation was employed, it would be possible to obtain air of much greater purity to force into the wards and rooms of hospitals.

If the city is built upon a flat area, great advantage can be obtained as regards ventilation by placing the hospital to the leeward side of a park, or a body of water, in order to have the side from which currents of air approach during the greater portion of the year as nearly as possible unobstructed.

SEWERAGE.

In large cities the matter of sewerage is usually so well arranged that little difficulty is experienced from this source, no matter where the hospital is situated.

In smaller cities, in which there is no perfect system, it is important to give the subject careful attention, especially since there is greater danger of contamination in hospitals than in other kinds of buildings.

SAFETY FROM FIRE.

In communities in which most of the buildings are constructed of wood it is well to select a location as far as possible removed from other buildings. This will prevent a panic among patients in case of fire in the neighborhood. Even in a perfectly fireproof hospital, with no actual danger of direct contact with fire, the risk of a panic is of sufficient importance to demand special attention to this feature in locating hospitals.

ACCESSIBILITY.

It is of the greatest importance to the patients occupying beds in hospitals, as well as to their friends, that the institution be located at a point which can easily be reached by them. This will also make it possible for the patients who are very ill to be transferred to the institution without great danger of injury from the transportation itself. The same condition will secure for the hospital upon its medical and surgical staff men of the highest skill and ability, who could not spare the time to travel a considerable distance into the country to care for hospital patients. Since the general introduction of the rapid transit facilities and the automobile this argument has lost much in importance, and it is possible that the idea long favored by that great authority on hospital matters, Sir Henry C. Burdett, of locating all hospitals in the country, may yet be realized.

In the larger cities of this country one invariably finds many limitations. Were it possible to place hospitals in the middle of our public parks, it would be an easy matter to secure all of the conditions which have just been mentioned. It is, however, rarely possible to obtain more than a city block, containing five acres of land, even for a large hospital. A careful study of conditions in the larger cities of this country will, however, show that in all of the details mentioned it will be possible to secure fair conditions by erecting many storied buildings in place of following the cottage system which was so popular during the latter part of the last

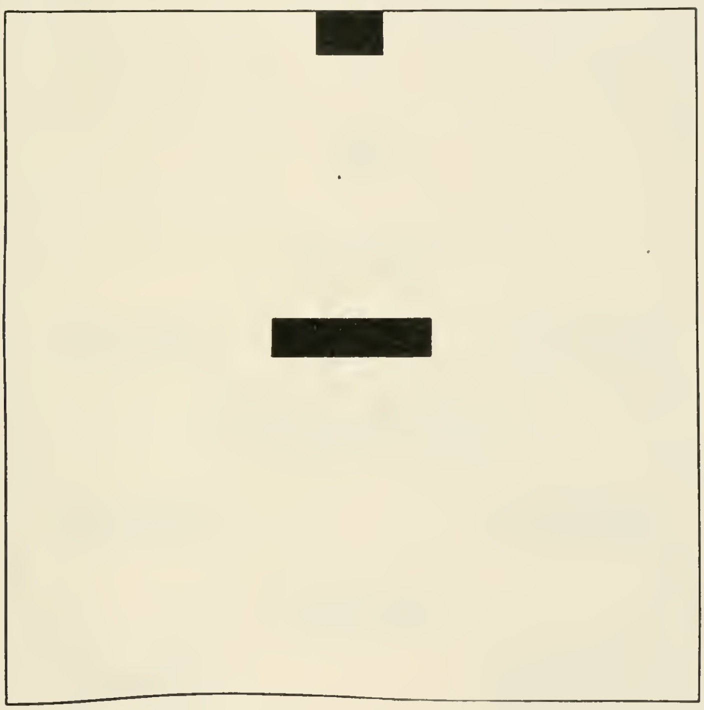


FIG. 3.

century. It will be interesting to consider all of these conditions from the standpoint of the erection of high buildings.

In considering the relative merits of the many storied hospitals as compared with the cottage hospital, a number of points have been introduced which have no direct relation to location, but for convenience sake it has seemed proper to introduce these elements at this point.

LIGHT.

In order to illustrate the possibilities, especially for securing favorable conditions for lighting and ventilation, a diagram has been made of a block of land such as might be secured under the most favorable circumstances by a city requiring a hospital for 500

patients. This block contains a tract of five acres. Figure 3 represents this tract of land containing in its central portion an oblong space, representing the number of square feet required for the foundation of a ten-storied building, which would readily house 500 patients, at the same time furnishing the necessary space for the administration department in the first story, and the operating department, with recovery rooms and the kitchen department, in the top story, and upon each floor a sufficient amount of space for service-rooms, diet-kitchen, bathrooms, toilet-rooms, linen-rooms, etc.

It also contains a second space to be occupied by the boiler-house and laundry.

Figure 4 represents the same area of land occupied by ten

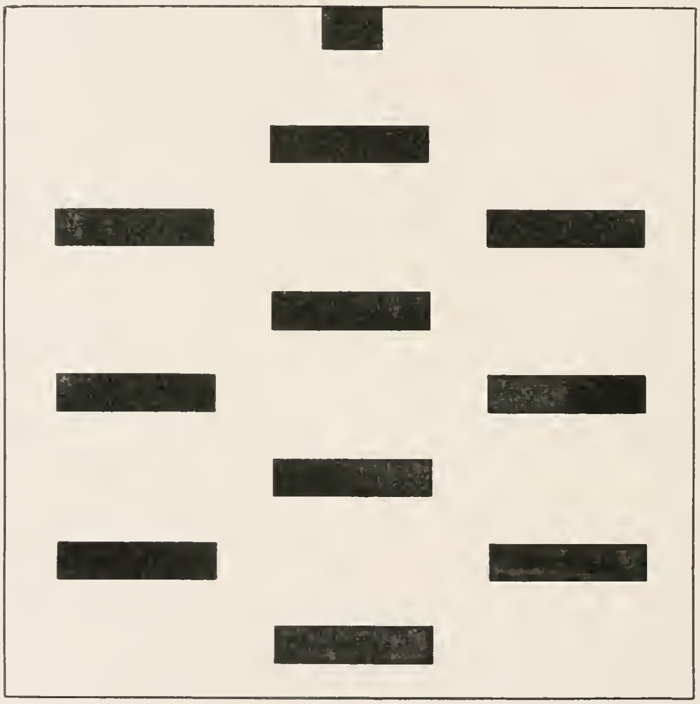


FIG. 4.

single-storied pavilions, also calculated to house 500 patients, with the necessary operating-rooms, kitchen, boiler-rooms, etc., giving each patient the same amount of air space that was alloted in Figure 3.

Figure 5 corresponds to Figure 3, except that instead of a five-acre lot, a block of land is taken such as is common in most of the cities of this country, having a frontage of 520 feet on each side.

Figure 6 corresponds to Figure 4, with the same exception.

A glance at these diagrams will demonstrate a number of im-

portant facts which are well borne out in practice in all of the larger institutions which have been built in the larger cities of this country.

In Figures 3 and 5, in both of which the building is shown as extending from north to south, there can be absolutely no obstruction to light. The dimensions of this building are 60x250 feet, with the hall extending the entire distance from north to south. This condition insures for every room and every ward in the entire building unobstructed sunlight during some portion of the day; one-half being exposed to the morning sun, the other half to the afternoon sun, and the hall to the noonday sun. The building should, of course, have broad verandas at the north and south

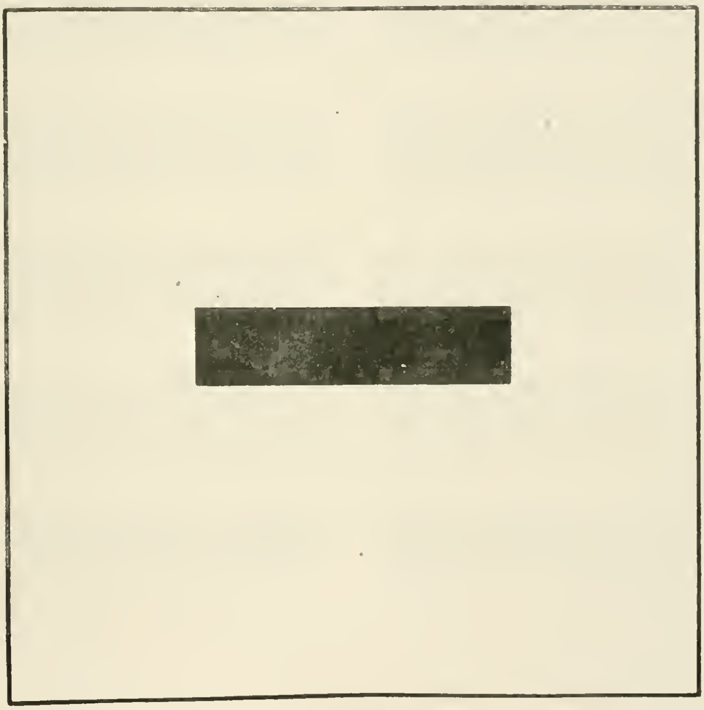


FIG. 5.

ends, with broad doors communicating with the central hall, permitting patients to be placed out of doors in beds or on couches or in wheel-chairs.

The same conditions apply to ventilation. We have here a building which is absolutely unobstructed from all sides. In most cities in this country the ventilation must come during the greater portion of the year through open doors and windows, and there can be no doubt but that the passage of air through a building standing as free from all obstructions as the one in Figures 3 and 5 must be much more perfect than through a building such as indicated by Figures 4 and 6.

It is a well-known fact that there is a marked difference in the rapidity with which the atmospheric air travels near the ground and at a considerable elevation, especially if there are large objects which obstruct the circulation near the ground; consequently one can notice a difference in the air in the first and fifth or sixth stories of any tall building.

In considering the fact of ventilation it is further important to bear in mind the advantage that can be obtained by getting away from the dampness of the earth. No one would choose to sleep in the first story of his dwelling house, because the air in the

FIG. 6.

second or third story is practically always freer from dampness. The matter of dampness is still further increased if a considerable portion of land is covered with buildings, because of the shadows which will be thrown over the greater portion of the land during the various parts of the day.

A glance at Figures 3, 4, 5 and 6 will convince any one of the vast advantage regarding sunlight and natural ventilation which is offered by the many-storied building.

But there is still another primary consideration, which in large cities especially is of great importance, the contamination from street dust.

Woodbridge makes the following statement: "City air, as

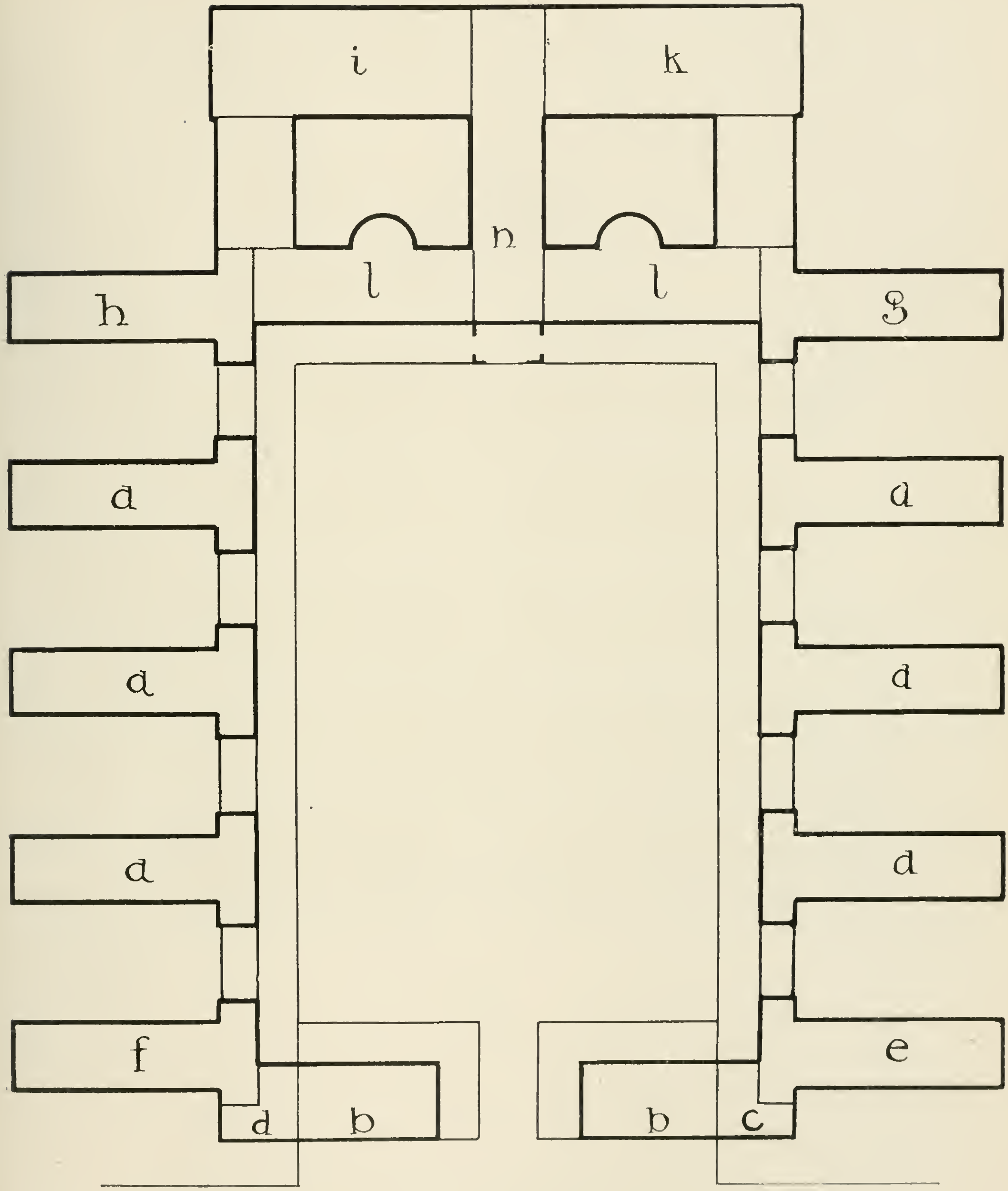


FIG. 7.

a, ward buildings; b, administration; c, physicians' rooms; d, policlinic; e, dispensary; f, kitchen; g, laundry; h, Sisters' quarters; i, lockers and stable building; k, morgue; 1, baths. See Fig. 294 also.

shown by reports from tests, has been found to contain as many as 450,000 germs to the cubic foot. The dust gathered from collecting places within rooms of buildings has furnished 2,000 colonies

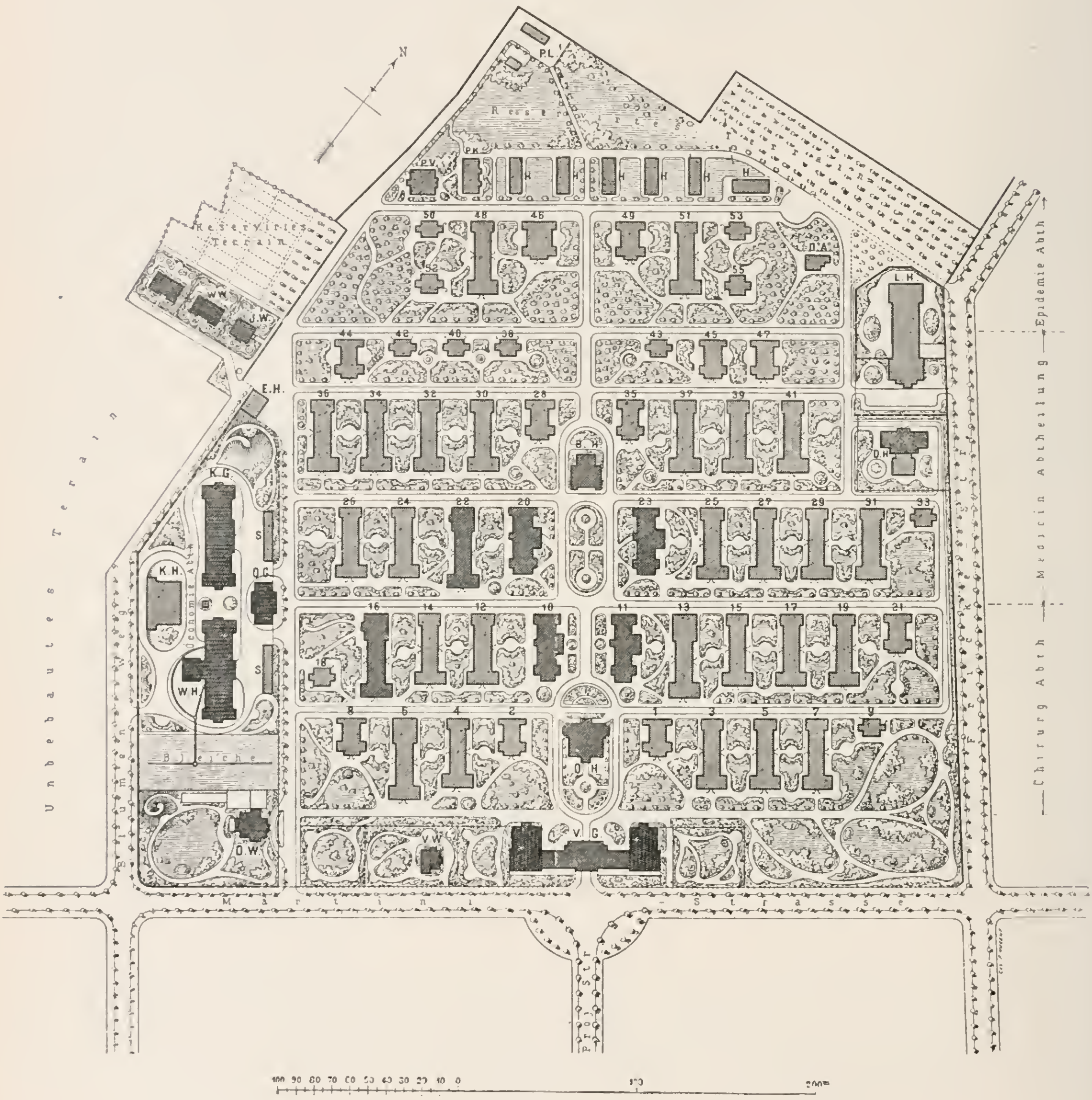


FIG. 8.

to the milligram of dust. The street dust in the cities having macadamized roads has been found to contain from 30 per cent. to 50 per cent. of horse droppings, and dust from hospitals has been found to contain from 35 per cent. to 45 per cent. of animal matter. It has been found that in the country air contains far less dust, especially of organic character, than in the city."

Figures 4 and 6 show that more than half of the buildings in the cottage plan are so near the street that the air must constantly be filled with street dust; moreover, experiments, as stated, have proved that at a given point within a great city the amount of street dust at the level of the first story is vastly greater than the amount in the higher stories, because of the weight of this dust.

Aside from this it is possible to place a natural screen between the building (in Figures 3 and 5), and the street, in the form of shrubbery and small trees, which will be far enough away from the building not to cause dampness of the soil by a great amount of shadow. In this manner the greater portion of the street dust can actually be screened out of the air before it reaches even the first story of the building—which, of course, is not possible if the building is placed near the street, as it must be in Figures 4 and 6.

What has been said can be illustrated in practice by a study of the plots of some well-known hospitals. Fig. 7 represents the ground plan of the famous hospital Lariboisiere, in which the amount of space occupied by buildings is so great that the intervening space is covered by shadows a great portion of the time. Fig. 8 represents the plan of the equally famous hospital Neues Allgemeines Krankenhaus zu Hamburg-Eppendorf, which will be mentioned repeatedly in connection with this work. Figure 8 also shows a very large portion of the ground covered with buildings; in this instance the danger of contamination from street dust is eliminated by the planting of shrubbery along the street in front of the buildings.

CHAPTER X.

ORIENTATION OF HOSPITAL BUILDINGS IN RELATION TO SUNLIGHT.

The subject of hospital orientation has of late been thoroughly considered, and it is of the very greatest importance in the planning of such buildings. In a recent address, Mr. William Atkinson has considered the subject so carefully in connection with the orientation of streets that the portion relating to buildings in general can be applied directly to the planning of hospitals. The author has kindly consented to the use of his article in this volume, and the following pages are quoted verbatim:

"*The Orientation of Buildings and of Streets in Relation to Sunlight*" is a subject that I have been led to investigate in connection with the study of hospital architecture, but the results are equally applicable to the construction of all buildings occupied for residential purposes. If sunlight is essential for the recovery of the sick, is it not a still more powerful agent in the prevention of disease?

"Unquestionably the first requisite for a hospital is abundance of sunlight. Not only the exterior wall surfaces of the buildings, but also the ground surfaces between and around them should have the direct rays of the sun for as long a time as possible each day.

"Second only to air is light and sunshine essential for growth and health; and it is one of Nature's most powerful assistants in enabling the body to throw off those conditions which we call disease. Not only daylight, but sunlight; indeed, fresh air must be sun-warmed, sun-penetrated air. The sunshine of a December day has been recently shown to kill the spores of the anthrax bacillus." (Galton, "*Healthy Hospitals*")

"Wall surfaces, especially brick walls, absorb a large amount of moisture during rains. This moisture is quickly dried out by exposure to sunlight, but is retained for a long time in walls which are not exposed to the sun, and creates an unhealthy condition; for dampness, with lack of sunlight, is a combination favorable to the growth of low forms of vegtable life, and should be avoided in hos-

pital buildings. To secure sunlight in the fullest measure requires that the general plan of the buildings shall be carefully studied with this end in view.

"In the study of existing hospitals I have found the greatest divergence in the orientation of the buildings. It therefore seemed

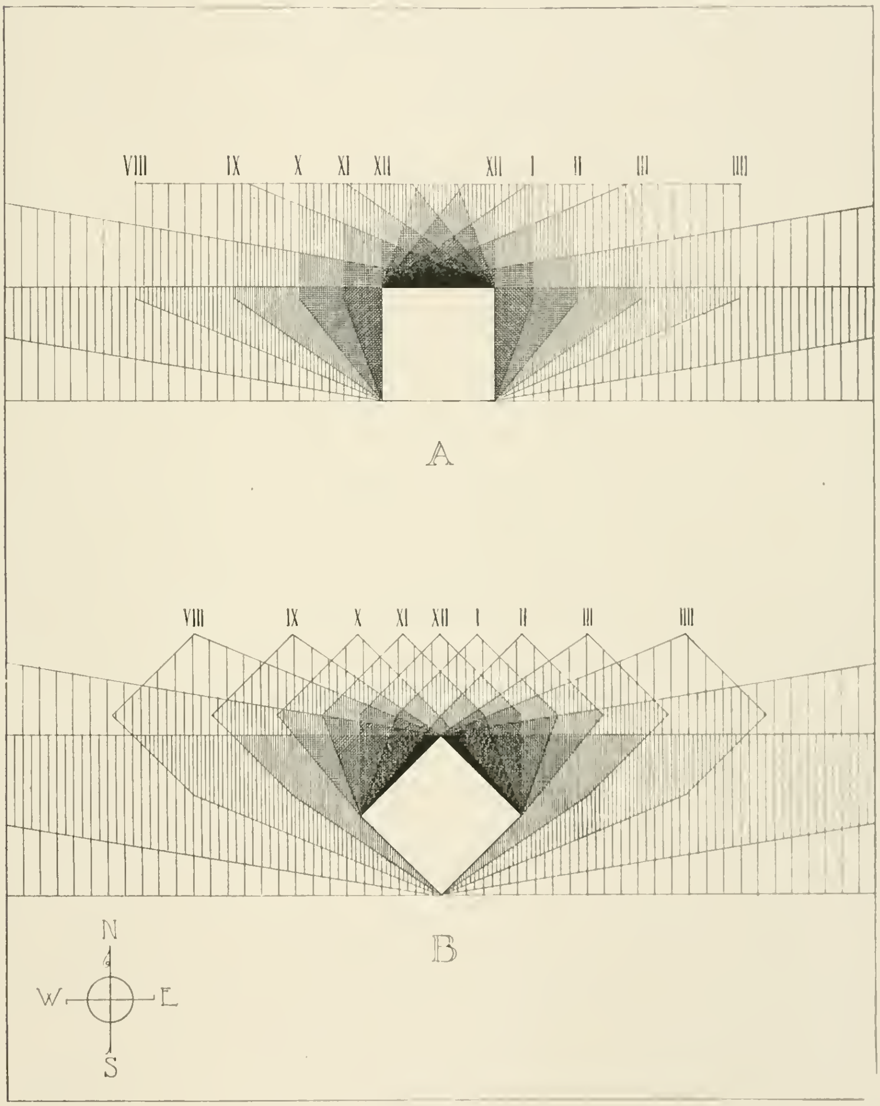


FIG. 9.

to me advisable to make an investigation of the subject, and several years ago I obtained from the Harvard Observatory a table showing the position of the sun for different periods of the year, and the data thus obtained are embodied in a sun chart which I will now show you. (Fig. 15.)

"Astronomy is not studied nowadays as it used to be, and perhaps it will be well to refresh our astronomical knowledge a little. These three diagrams show the position of the sun at each hour of the day for the three typical seasons of the year: December 21, the shortest day; March 21 and September 21, the equinoxes, and the longest day, June 21. There are several things that it will be convenient to fix in our minds. In the first place, we see that the sun rises pretty nearly in the northeast in summer and sets pretty nearly in the northwest, and in winter the same distance southeast and southwest. At the time of the equinoxes it rises in the east and sets in the west.

"Another thing convenient to remember is that in June about 8 o'clock in the morning the sun is very nearly due east, and at 4 o'clock in the afternoon very nearly due west. Then I would like you to observe the low altitude of the sun at noon in winter and the high altitude in summer. In one sense the period of equinoxes may represent the average day because it is intermediate between the two extremes; but the declination of the sun is changing much more rapidly at those periods than it is in June and December. Consequently there are a great many more days which resemble the 21st of December in winter and a great many more days in summer which are typified by June 21st than there are days which are typified by March 21st and September 21st. You will find if you consult the almanac, that the length of days is changing very slowly around December 21st, and June 21st, and very rapidly at the time of the equinoxes. For instance, two weeks before December 21st, the length of the day is only eight minutes longer than on December 21st. So about June 21st, two weeks before and after, the day is only a few minutes (about seven or eight) shorter than it is on June 21st. On the other hand two weeks before March 21st, and two weeks later, on April 4th, it is forty minutes longer.

"The time shown upon these diagrams is the time as shewn by a sundial, which is different from our eastern time, but the correction in each case can be made by consulting the almanac.

"This slide represents what I call the "first lesson" in orientation. It represents a building square in plan. In one position it is set squarely with the meridian, and in the other the meridian passes through the diagonal. You can see that in the first the north wall will obtain no sunlight at all during half of the year, whereas in the second all four walls of the building will have more or less sunlight at all seasons of the year. The typical home of the Swiss mountain dweller is a square building set on the diagonal with respect to the meridian, and the living room is placed at the

southern apex. Evidently the dwellers in these mountains learned to appreciate the value of sunlight at a very early date.

"This diagram (Fig. 9) represents the shadow plan of a cube placed in the two positions I have shown. The shadows are drawn for each hour of the day and are superposed one upon the other,

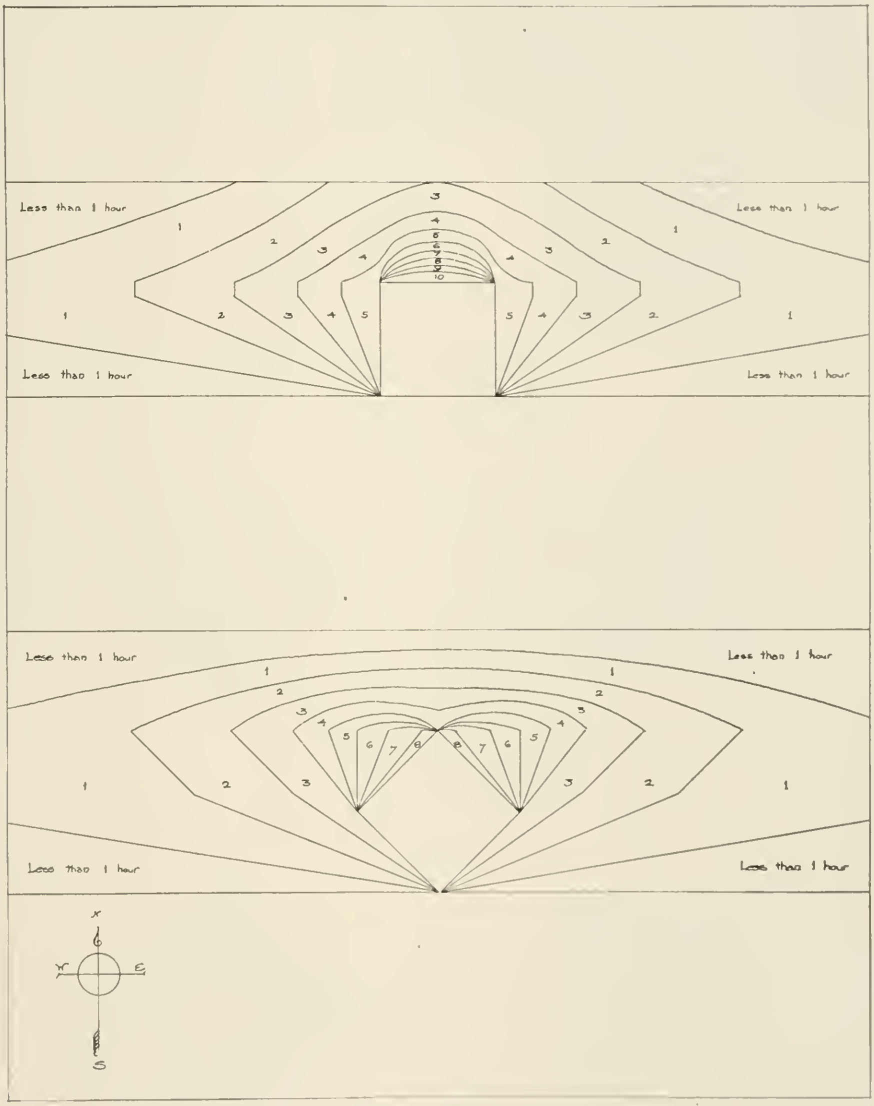


FIG. 10.

and the degree of blackness corresponds roughly to the length of time in which that particular spot is in the shadow during the day; the full black in that case represents an area which is in sunlight for less than one hour. You will observe that in this position (A) of the cube there is a very considerable triangular area here, much larger than in the one (B), which has very little sunlight. In other

words, a square building placed in the latter position shades the ground around it very much less than a similar building placed in that position (A). The diagram suggests another and better

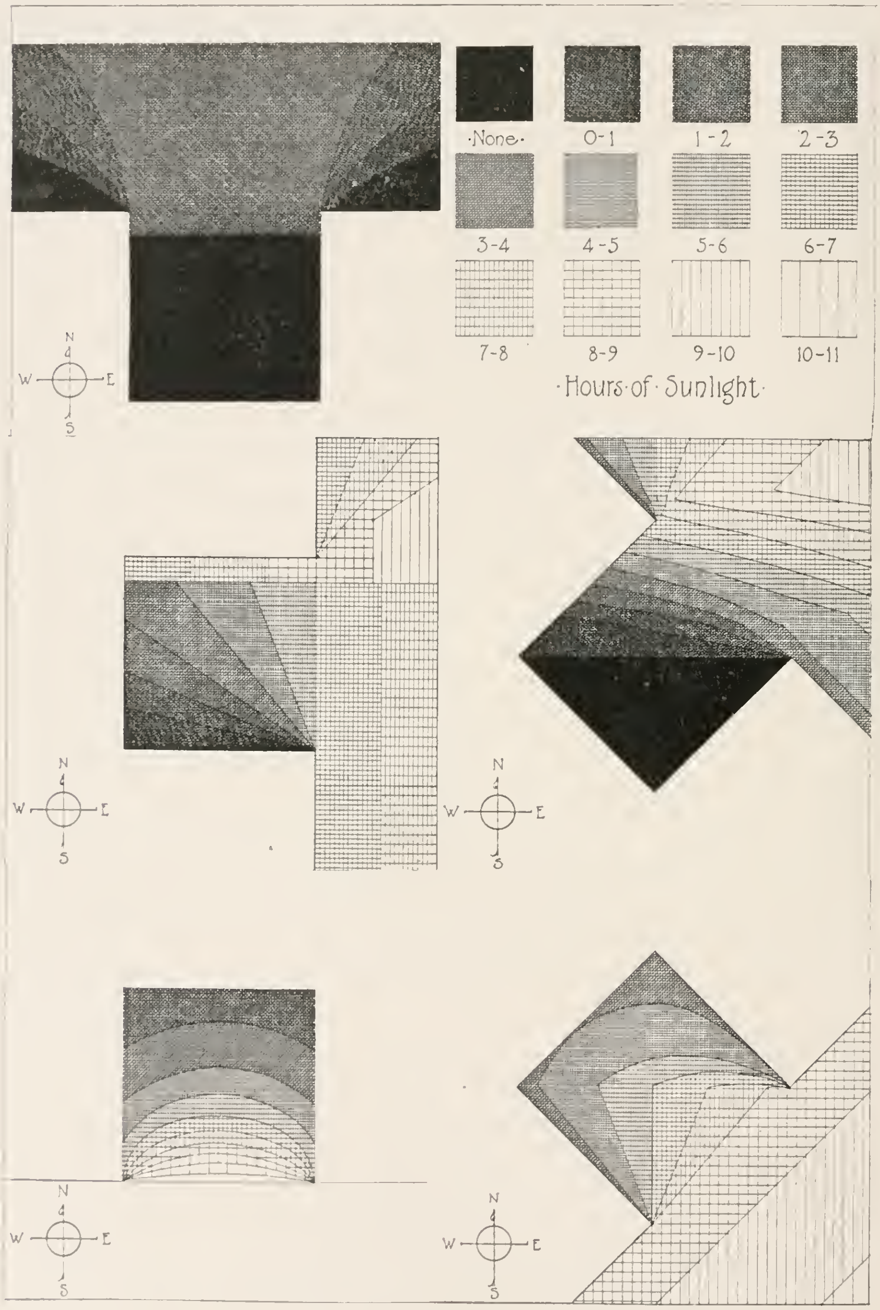


FIG. 11.

method of representing these matters by means of curves. The intersection of the various shadows will determine one series of points in shadow for two hours, and so on; and by joining these

points we obtain a series of curves which may be called shadow curves of the cube.

"The next diagram (Fig. 10) will show these shadow curves for March 21st and September 21st. In each area the numerals indicate the number of hours during which that area is without sunlight. Similarly we might draw such a shadow diagram for a building of any shape by pursuing the same method, but practically we find that almost all buildings, especially hospitals, are com-

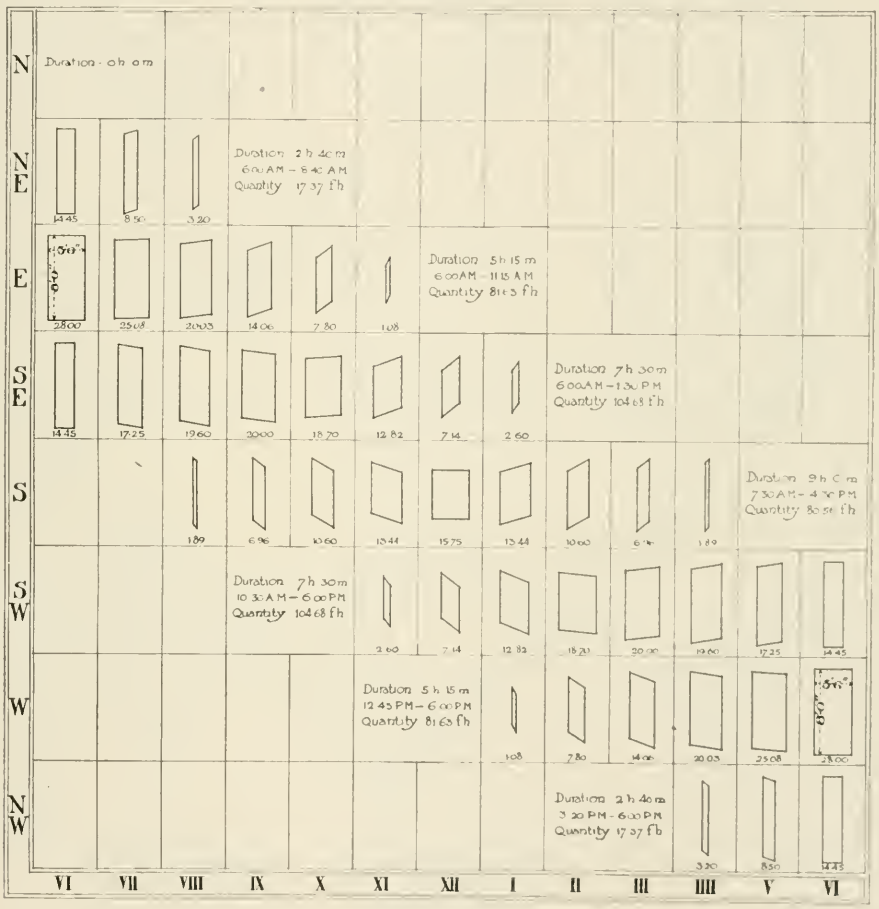


FIG. 12.

posed in their elements of two wings forming an L, or three wings forming a U-court. Especially are hospitals composed of U-courts, so that if we study the U-court we have accomplished the greater part of the necessary study.

"If we study the shadow plan of such a U-court (Fig. 11), we shall find the most advantageous position is that in which the court faces southeast or southwest, and the least advantageous is that in which the court faces the north; and yet how often do we see buildings constructed on this plan with the court facing the north

"So far we have considered the outside surfaces of the building and the surface of the ground around it. We now proceed to study the interior lighting of the buildings. This diagram (Fig. 12) illustrates the subject of windows. These various patches of

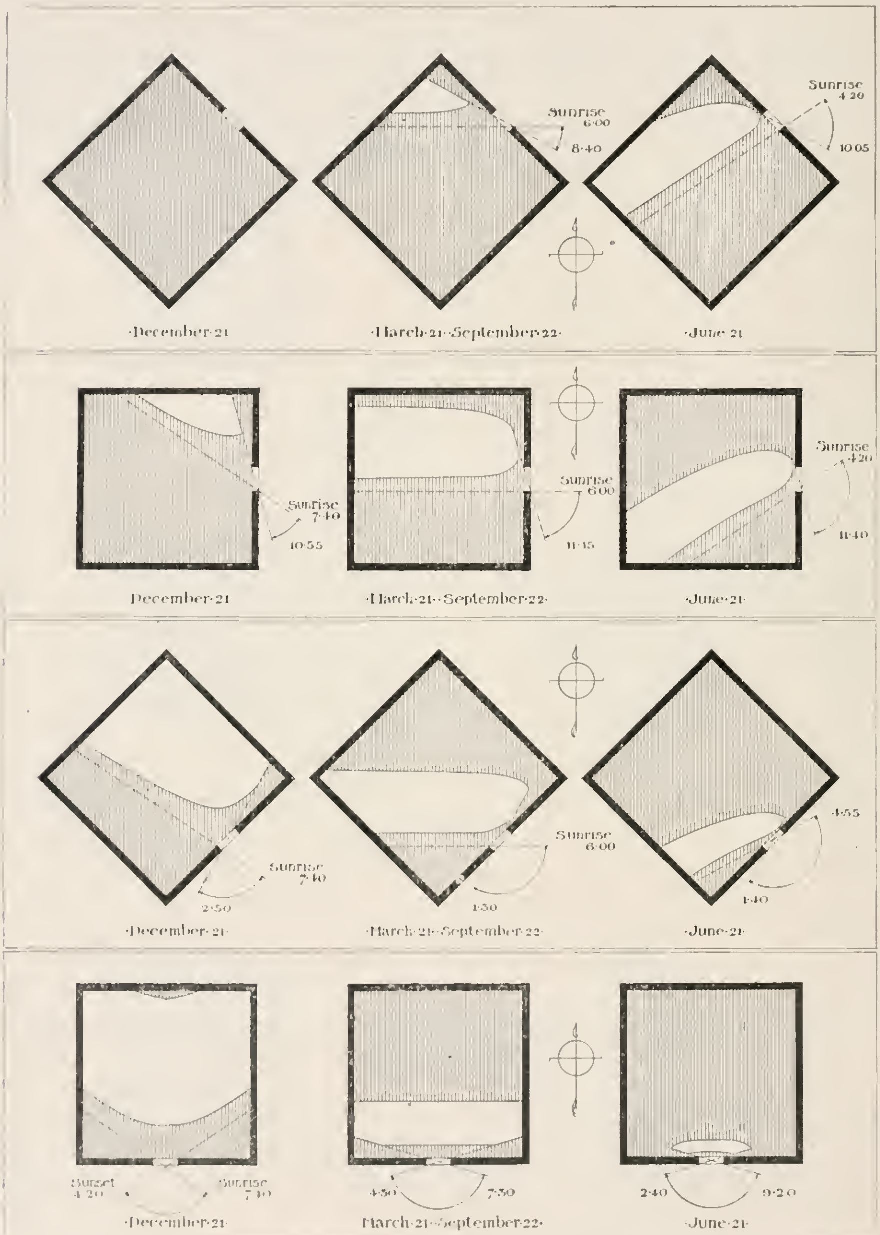


FIG. 13.

different shapes represent the cross sections of a prism of light rays passing through a window 8 feet high, 3½ feet wide, and a thickness of 1 foot in the wall. Now by multiplying the area of any

one of these figures by the length of time during which the sun is shining through the aperture of that shape, we shall obtain what I call 'quantity' of sunlight expressed in 'sun-hours,' the sun-hour being the amount of sunlight received by a surface 1 foot square exposed to the sun for one hour.

"This diagram (Fig. 13) illustrates the illumination of the floor through the window, and if the floor of that room were cov-

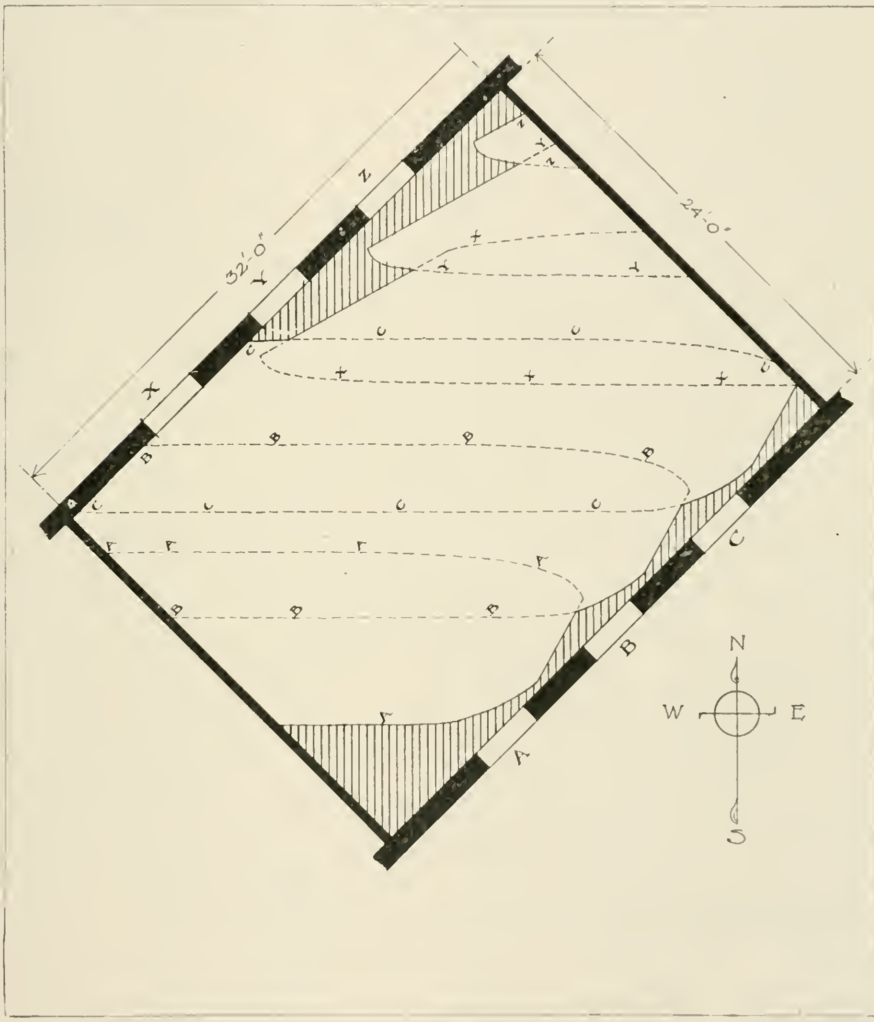


FIG. 14.

ered with a carpet dyed in aniline colors, we should find at the end of the day the unshaded portion somewhat faded, because that represents the area of the floor which has received sunlight during the day. The diagram is drawn for the four typical seasons of the year. The south window is one of the extremes; in winter it transmits a great amount of sunlight, but in summer, owing to the great altitude of the sun, this small patch of floor is all that receives sun-

light during the day; so the south window is a very cool one in summer and a very warm one in winter. By superposing these areas on any given plan we can obtain the floor illumination of a room of any shape and with windows variously placed.

For instance, this diagram (Fig. 14) represents an open ward in a hospital."

This work of Mr. Atkinson's thoroughly establishes a scientific basis for the placing of hospital buildings as regards the in-

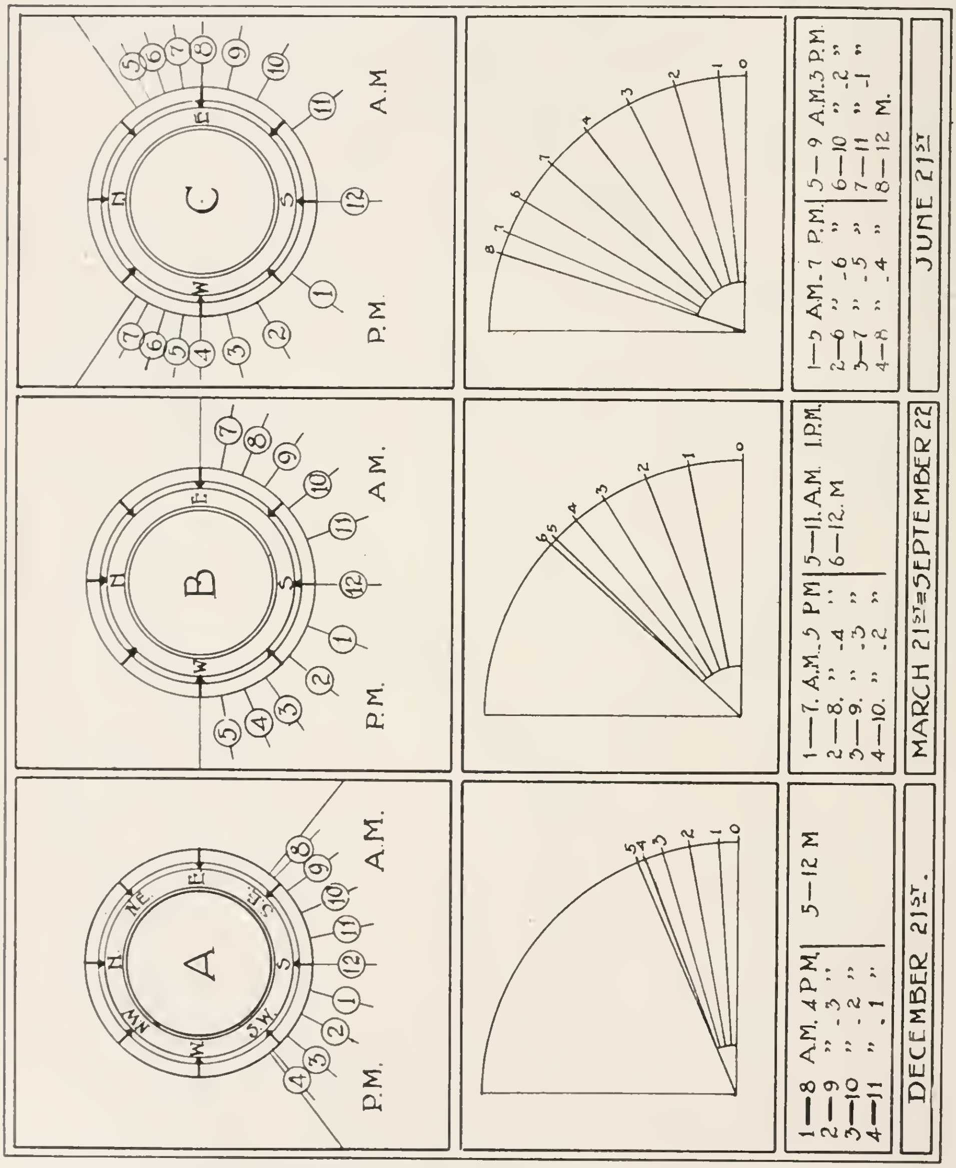


FIG. 15.
Sun Chart.

troduction of sunlight. Mr. Atkinson has also made a most careful study of the distribution and depth of shadows in connection with buildings of various forms. The principal forms being those considered in the classification of hospital plans by Sir Henry C. Burdett.

1—The single straight block.

2—Two blocks arranged as an ell.

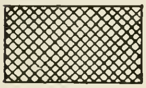
3—Three blocks arranged as the letter U.

4—Three blocks arranged as the letter H.

These forms have been placed in various positions so that each wall in turn extends from north to south, from east to west,

Key to Figures 16, 17, 18, 19.

Without sunlight from 8 a. m. to 4 p. m.



Without sunlight from 8 a. m. to 6 p. m. or from 6 a. m. to 4 p. m.

Without any sunlight whatever during the entire day.

from northeast to southwest, from northwest to southeast. The shadows are represented at various depths and indicate the percentage of wall surface which was without sun at any time during the day, between the hours of 8 a. m. and 4 p. m.

Fig. 16 represents a single oblong building placed from north to south. At A it will be seen that the area of ground which receives no sunlight between the hours of 8 a. m. and 4 p. m. is exceedingly small. If this building is constructed on the general plan which was represented in Fig. 1, then the windows on the entire east side of the building will receive sunlight during the entire morning; the sun will actually enter the room until a little after 11 o'clock. All of the windows on the west side of the building will receive sunlight during the entire afternoon; the sun's rays will enter the rooms from about 1 o'clock on. The hall will be exposed to sunlight from 8 o'clock in the morning until 4 o'clock in the afternoon, receiving almost parallel rays during the noon hour.

Again, referring to what has just been said concerning the difference between summer and winter sun, it will be seen that the hall will be more thoroughly sunned during the winter months, when sunlight is most desirable.

Referring to B, Fig. 16, it is plain that if the same general plan is employed that is shown in Fig. 1, aside from room 8 and room 1, the entire north side of the hospital will contain rooms which receive no sunlight at any time during the day. Rooms 10 to 14 inclusive will receive sunlight from 8 a. m. to 4 p. m. Room 15 will receive sunlight from sunrise until 11 a. m., and room 8 will receive sunlight from 1 p. m. until sunset.

It is plain that this plan of placing a pavilion would be most unsanitary.

Were the general plan represented in Fig. 2 adopted with a hall extending along the north wall of the building, the sanitary

conditions as regards the use of sunlight would be very satisfactory.

In C, Fig. 16, the pavilion extends from southwest to northeast; in both of these structures there is no portion of the surrounding ground which is not exposed to the sunlight during some

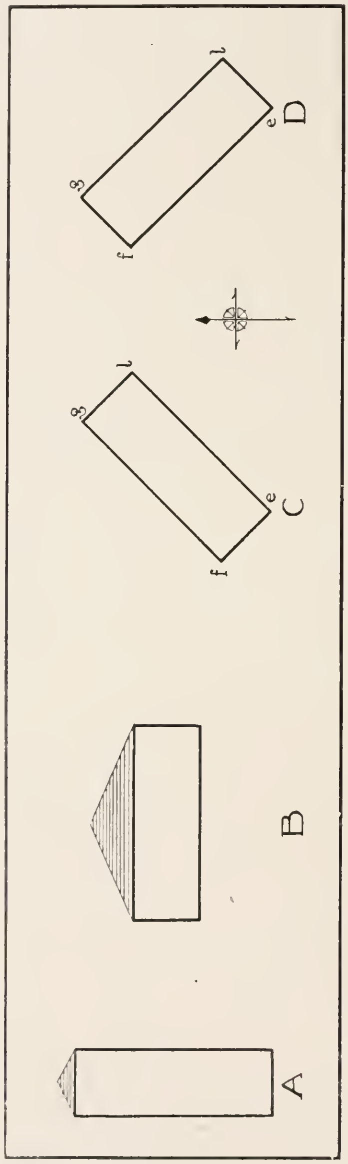


FIG. 16.

portion of the time between 8 a. m. and 4 p. m. This ensures the sunning of the entire hospital grounds and all of the outside walls. Every window in the hospital receives sunlight during a portion of the day. There is, however, this important fact to be borne in mind, that although the windows themselves are exposed to sun-

light, the portion of the walls l-g and f-g, in C and D, Fig. 16, prevents the actual entrance of any considerable amount of sunlight into the rooms during the winter months when sunlight is most appreciated. This is so because in winter the sun rises in the southeast, and sets in the southwest, as shown in A, Fig. 15.

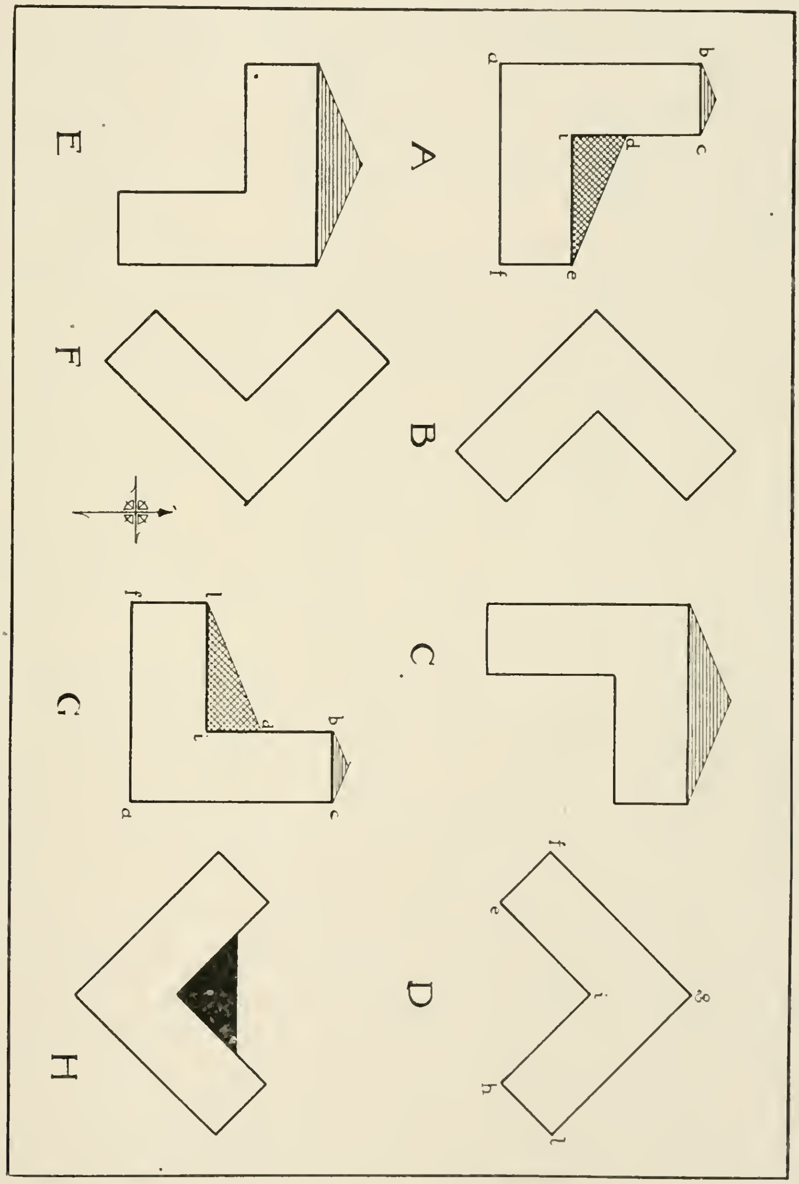


FIG. 17.

During the summer months, when the sun rises in the northeast and sets in the northwest, as shown in C, Fig. 15, this condition is changed because in these walls the windows will admit a considerable amount of sunlight until about 9 o'clock in the morning. The walls f-e and e-l are placed very favorably for the recep-

tion of sunlight both in summer and winter. Were it feasible from the standpoint of economy to employ the general plan represented in Fig. 2, most favorable conditions could be obtained by placing the long halls along the walls f, g, C, Fig. 16, and g, l, D, Fig. 16, thus exposing the side of the hospital containing the rooms along the wall e-l in C, Fig. 16, and f-e in D, Fig. 16.

In considering the plan of two wings of a hospital in the form of the letter L, as shown in Fig. 17, we have a combination of the shadows represented in A and B, Fig. 16, together with the condition represented in H, Fig. 17, in which a considerable portion of the ground receives absolutely no sunlight between the hours of 8 a. m. and 4 p. m.

What has been said regarding A and B, Fig. 16, is true of A, C, E, G, Fig. 17; and what has been said of the effect of sunlight in C, D, Fig. 16, is also true of B, D, F, H, in Fig. 17; the unfavorable conditions, however, being badly exaggerated in H, Fig. 17, because the advantage which each wing obtains from its oblique position is lost by the fact that a considerable portion of the walls on the northeast side of the west wing, and northwest side of the east wing are constantly in each other's shadow.

The least unfavorable of these structures, so far as sunlight is concerned, is found in D, Fig. 17, provided the building is constructed so that the hall extends along the wall f, g, l, and the rooms along the opposite wall.

Another plan will be shown later according to which this form of a hospital placed as shown in D, Fig. 17, may be made satisfactory as regards the use of sunlight. This implies the use of large wards in public institutions in which a long wing is utilized as an open ward, the east wing receiving an abundance of sunlight through the walls, l-h and h-i, the west wing receiving an equal amount through the windows in walls f-e and e-i.

The same principle may be applied to buildings constructed according to B and F, Fig. 17. A, C, E and G may be utilized in a fairly satisfactory manner by placing the elevator and stairs, the diet kitchens and serving rooms on the side of the building containing the shadows, and utilizing the other portions for wards and rooms. Of these figures A and G are the most favorable, because in these parts of the building the portion of wall which is entirely unexposed to the sun's rays between the hours of 8 a. m. and 4 p. m., is comparatively small.

In A, Fig. 17, the shadow upon the wall b-c may practically be ignored because an abundance of light for that portion of the building can be obtained through the windows in walls a b and c d. The shadow d e i may be ignored in part as the windows in wall e f will

supply sunlight for a portion of the end of the building affected by this shadow.

G, Fig. 17, is exactly the reverse of A, Fig. 17, and consequently the same criticism would apply to this form of building. In both of these rooms, elevator, diet-kitchen and stairs should be

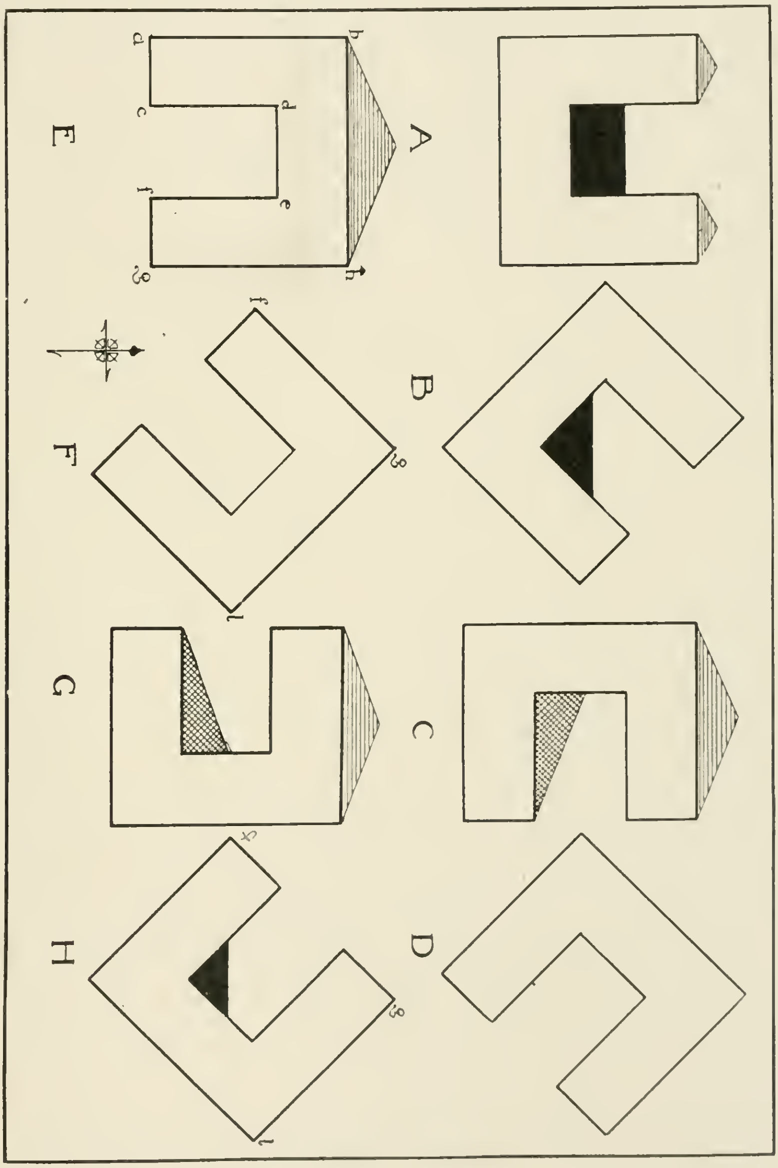


FIG. 18.

placed along the portion of the walls indicated by the lines e i and d i, the remaining wall space being utilized for rooms and wards.

The most popular of all forms of construction, in large cities at least, is that represented by three wings placed in the form of the letter U, as shown in Fig. 18. A combination of the conditions

represented in Figs. 16 and 17 will produce the conditions represented in Fig. 18. A study of the separate figures in this illustration will at once condemn three of the positions indicated, namely A, B and H, and of these A is undoubtedly the most undesirable, as it contains the greatest area of ground, and the greatest area of wall space which receives absolutely no sunlight between the hours of 8 a. m. and 4 p. m. The same objections that were urged against the walls f g in C, Fig. 16, and g l in D, Fig. 16, will apply to the walls f g and g l in D and F, Fig. 18, and to f g in B and g l in H, Fig. 18. One of the most satisfactory positions for a hospital of this form is shown in E, Fig. 18, this is also shown in its practical application in hospital construction in Fig. 320, and this will be discussed in all its details later.

The form and position as shown in E, Fig. 18, is worthy of our very careful consideration. In this plan the halls should extend as indicated in Fig. 320, with large windows at the end of each hall and also in the center of the wall d e, Fig. 18. The walls a b and e f will be exposed to the sunlight the entire afternoon, the walls c d and g h the entire forenoon. The walls a c and f g will be exposed all day. Portions of the wall d e will also be exposed to the sunlight during the entire day; this will leave only the walls b h without sunlight between the hours of 8 a. m. and 4 p. m. It will, however, be possible to secure sunlight for a considerable portion of this space by arranging the rooms as indicated in Fig. 320, because the windows placed in the walls a b and g h will readily supply this light. The remaining portion of the space along the wall b h can be utilized for elevators, stairway, diet kitchens and service rooms, and in general hospitals for the rooms allotted to eye patients, as these rooms can be more easily darkened than they could be were they situated in the sunny portions of the hospital.

In many storied buildings the top story can be utilized for operating rooms, thus securing north light, which is the best possible light for this purpose. By still further combining these wings or pavilions a form will be obtained which may be represented by the letter H, as shown in Fig. 19. This is virtually a combination of the forms A and E, C and G, B and F, D and H, Fig. 18, placed in groups.

What has been said in the discussion of forms in Fig. 18 will apply fully to the forms in Fig. 19. In some of the larger municipal hospitals in which the male and female patients must be separated, form A, Fig. 19, presents many attractive features if the portion a b c d in A, Fig. 19, is built up not more than two stories high in the many storied buildings, this portion being utilized for the administration department, and the two wings being used one for

the male and one for the female patients. The advantage from the point of convenience of the central location for the department of administration, is, however, not so great when compared to the conditions in Fig. 320, to make this form desirable. The space occupied by the elevator and stairs, by the service rooms and diet kitchen may be placed along the wall b c to advantage.

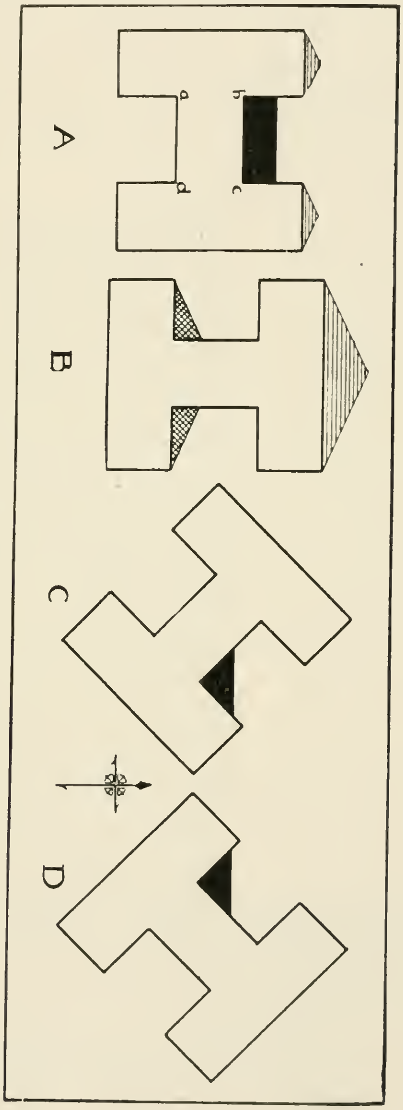


Fig. 19.

Atkinson has shown that in the space represented by Figs. 16, 17, 18 and 19, the following percentage of wall surface is without sun at any time during the day between the hours of 8 a. m. and 4 p. m. In Fig. 16, A, $12\frac{1}{2}$ per cent; B, $37\frac{1}{2}$ per cent; C and D, none; Fig. 17, A, 28 per cent; B, none; C, 25 per cent; D, none; E, 25 per cent; F, none; G, 28 per cent; H, 10 per cent. Fig 18, A, 27

per cent; B, 7 per cent; C, 30 per cent; D, none; E, 22 per cent; F, none; G, 30 per cent; H, 7 per cent.

It is plain that a large number of variations may be produced by placing these buildings at every possible angle and by combining a number of these forms, but perhaps this discussion will be suffiicent to at least demonstrate the necessity of giving careful attention to this element in the construction of hospitals.

CHAPTER XI.

MASONRY.

GRADE.—In establishing the grade of building to be erected, if it is possible to do so, the highest point should be taken as inside grade, and the entire lot graded off from this point with a slight

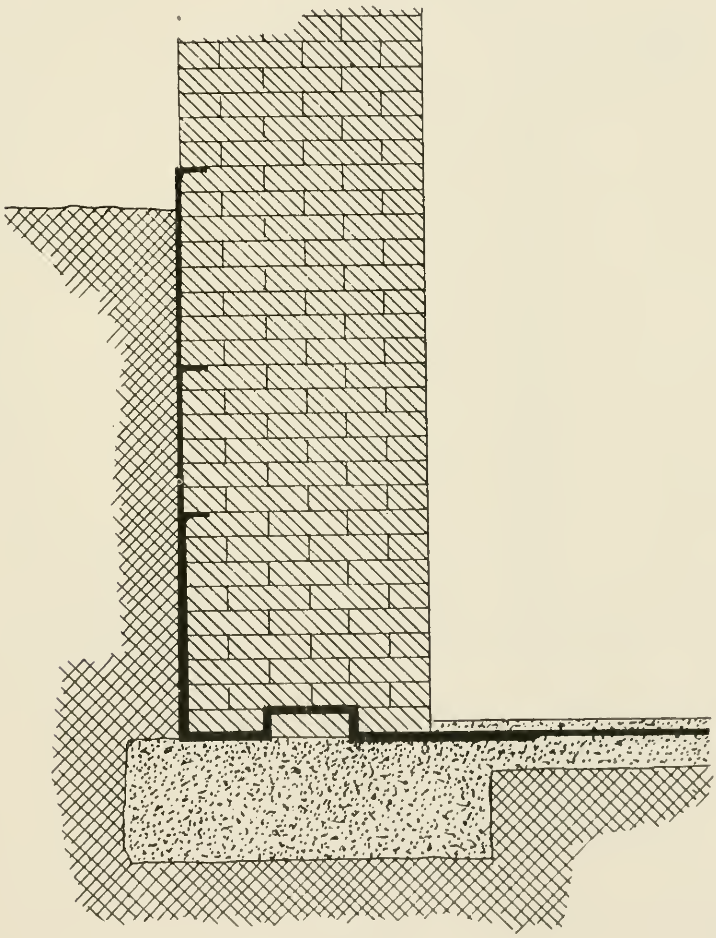


FIG. 20.

slope, in order to give perfect drainage at all times. Where this is not expedient, owing to the necessity of locating the hospital advantageously, as herein mentioned, it is well to take the highest point within practical limits, and grade the entire lot to such a

point. The primary object in this should be to afford, as stated, a perfect drainage away from the building, and to properly facilitate the keeping of the basement in a dry and sanitary condition.

Excavations.—Having decided this point, the matter of excavations is of next importance, as too often the specifications do not call for this in a proper manner. Care should be taken that in

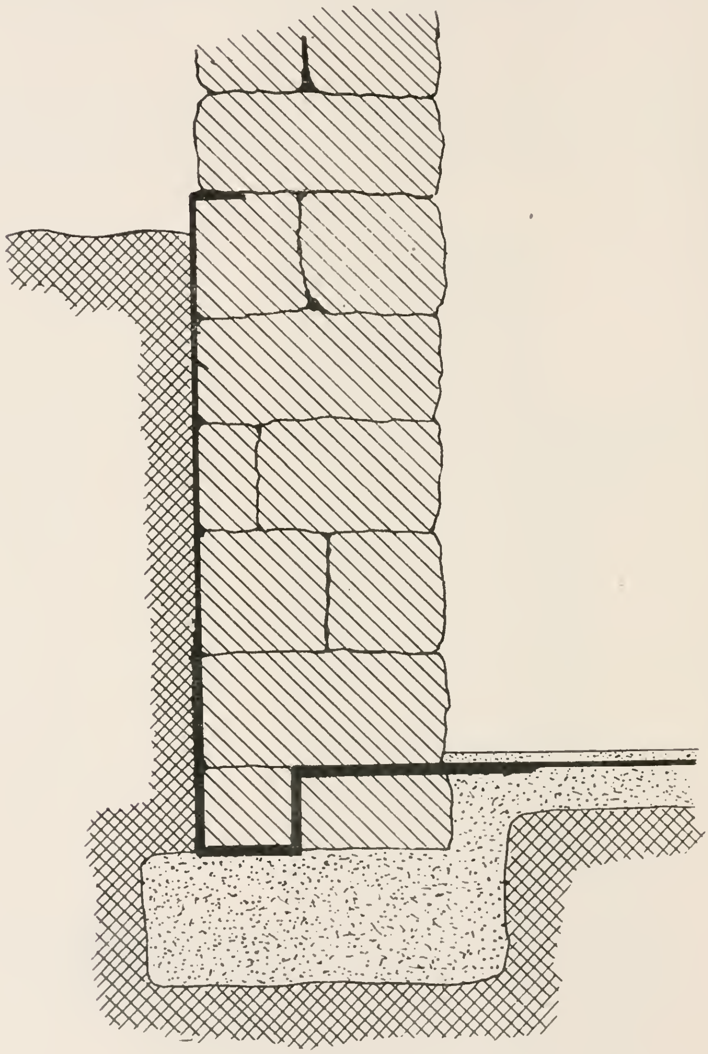


FIG. 21.

making the excavations they be sufficiently large to admit of the working on the walls outside, which are to be covered only after the foundations are above grade. The object in doing this is to permit plenty of room for the damp-proofing, so that this may be inspected as well as properly done, and because the cementing of damp courses between the footings and the foundations is a mat-

ter which requires special attention and must be done in a space where easy working is possible.

Footings.—The matter of footings must be left entirely to the architect, but as far as practicable these should be of concrete and put in so that they will adequately bear the building. Too often footings are designed for a hospital which may be of sufficient area, but proper care is not taken in making them in such a manner that damp-proofing can be facilitated. Damp courses, if used instead of cement coatings which have been damp-proofed by the process described below, must be built in with the foundation walls, laid in proper cement and in approved manner, so that they are what their name implies. They must have sufficient projection beyond the outside wall (Fig. 20), so that the cementing of these walls can be easily done, and there must be sufficient projection into the building so that the damp-proofing of the floor and that of the walls will be continuous (Fig. 21).

Foundations.—The foundation work must be given special attention. It will not suffice to build foundation walls as is done in buildings of ordinary character. It is probably necessary in the hospital more than in any other building known that these should be built correctly, and too much care cannot be given to this part of the work. Such foundations should either be built entirely of concrete, well plastered with cement which has been water-proofed with the compounds mentioned, or if built of stone should be laid in cement mortar, and the utmost care taken to damp-proof these walls, especially on the outside, so that none of the soil gases or dampness can penetrate them. Care must be exercised so that none of the so-called damp-resisting paints or damp-resisting methods be applied, unless they have been thoroughly tested for their permanent elasticity and their ability to withstand gases if those with felt are employed. A good coat of cement, with damp-proofing material mixed in dry before it is applied, is thoroughly good and has the added advantage of economy. The compound is a powder used in very small percentage of the weight of dry cement and will make the latter impervious to water.

There are several ways of building foundation walls, and a multitude of materials from which they can be built, all of which must be left to the discretion of the architect, and, to some extent, to the conditions existing for obtaining of material for these walls.

In leaving holes in the foundations for drains, gas and water pipes, the utmost care must be exercised to see that these are tightly closed after the pipes are in place. If it is possible to do so, excavation should be left open until all work of this character is

completed. This is not always expedient, nor always necessary, but it is a good rule to follow where it can be done.

Exterior Material.—In selecting material for the superstructure it will be necessary to use such as will best carry out the design of the building, but under no circumstances should the latter be made the primary purpose in the construction of the building, rather the design should be subservient to the material of which it is best to build the hospital. It will take no great amount of genius to use whatever materials are at hand and best fitted for the work, to make a practical as well as an artistic-looking building.

The watercourse can be of either terra cotta or stone and

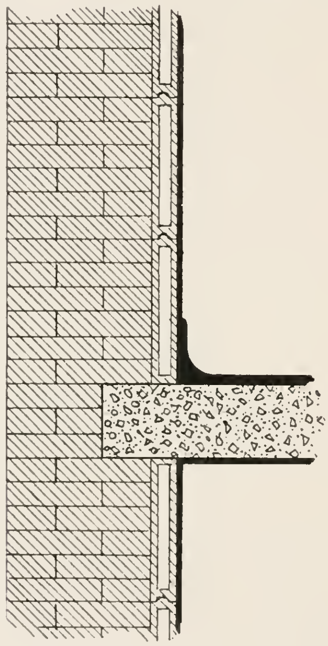


FIG. 22.

should be waterproofed on five sides with damp-resisting compounds to keep out moisture. Structure above that point must be left to the architect to carry out his design.

It has been found that the material best suited for the exterior of hospitals is brick, with stone or terra cotta trimmings, but stone, terra cotta and even cement, the latter in either reinforced work or in blocks, or a combination of all, can be used. Paving brick can be used with a greater degree of economy and with better results for tight, non-absorbent walls than almost any other material known. These should be laid in cement mortar and not more than eight feet in height to each length of wall, as there is liable to be a decided slippage if there is too much weight. But of whatever

material the structure be built, the primary object should always be to carry out the work with a view to economy without making an unsightly building. The outside walls, if of stone or brick, other than paving brick, can be treated with washes made for this purpose to prevent saltpeter stains and to waterproof the material. The inside of the outside walls can be treated in several ways—namely: Furring with the hollow tile (Fig. 22); hollow brick (Fig. 23); concrete blocks (Fig. 24), if brick, stone or terra cotta is used on the outside, but by none of these methods is one absolutely sure of preventing saltpeter spots on the plaster which is put directly on them. It could be avoided, however, by putting on furring and metal lath (Fig. 25), but this is an expen-

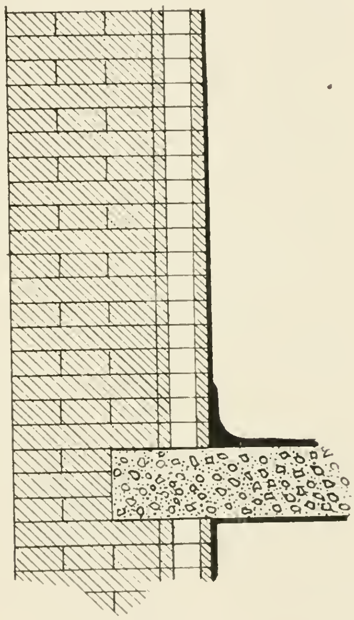


FIG. 23.

sive and useless method, inasmuch as there are now on the market compounds which, if properly applied, will do away with this bad feature with which the architect has had to contend heretofore. It may be said here that this also applies to the striking through of the saltpeter when hollow tile is used for walls, ceilings and partitions.

Damp-Proofing.—In the treatment of walls for damp-resisting in order to prevent moisture from coming through and avoiding saltpeter stains and to eliminate the expensive furring processes—i. e., do away with the air space—there should be put on a double coating of the damp-resisting compounds before the plastering is done; the first coat after the roof is on, and the second coat before the plastering is done. After the plaster is on it will form a per-

manent bond over this application, and has been found to be very efficacious in preventing saltpeter stains, which are so unsightly on fireproof buildings. In building the parapet walls (Fig. 26), the roof side should be given a coat of liquid cementatious paint. This latter, which is excellent, will prevent any dampness from creeping through the walls and down to the ceiling of the top floor.

When the above mentioned damp-resisting paint is put on the walls it should also be put on the under side of the roof. In this way an almost continuous damp-proofing is put on these walls, which will be found to serve the purpose very well.

It might be mentioned here that the walls of interior vaults

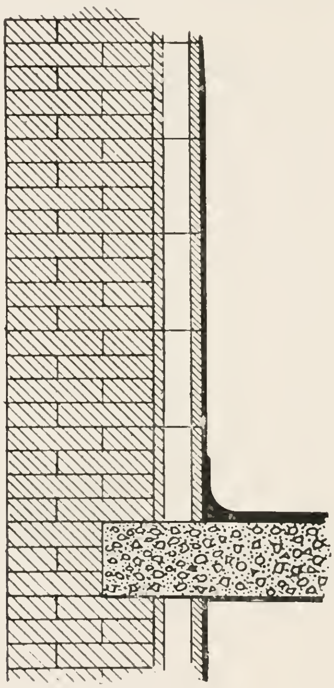


FIG. 24.

for the storage of documents, valuables, etc., can be treated with one of these damp-resisting compounds, and in this way do away with the ordinary mildew which forms in such air-tight places. However, if these are thoroughly dried out by salamander and are completely enclosed in the building there should be no such danger.

It will be necessary in using these compounds and so-called paints that they be alkali proof, so that the lime in the cement and in the brown coat of plaster should not affect them. On the other hand, they must contain no tar, for the reason that this would stain the plaster on the inner surface of the room.

Chimneys and Flues.—Great care should be exercised in the construction of chimneys and flues, as well as ventilating ducts,

in the building of hospitals. The latter are not so important as their function primarily is to convey air, and any leakage in them would not necessarily be of great danger except in contagious hospitals. It is, then, to this latter class of buildings that it would particularly apply. Chimneys, flues and ducts should be carried well up so as not only to create the necessary drafts, but in order that the discharge from them be diluted at as great a distance as possible above the habitable parts of the hospital.

Except in very large hospitals, from 500 beds up, in which a special and isolated mechanical plant would be required, the

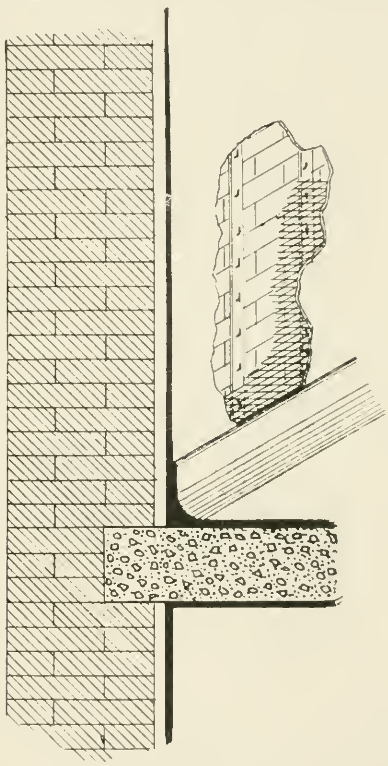


FIG. 25.

construction of the chimneys from the main boilers should be given special attention. Such chimneys should be built for at least 40 or 50 feet of their height above the boiler with fire brick, and under all circumstances should be built with an air space from top to bottom (Figs. 27 and 28). With a little care and ingenuity this space often can be used for the ventilation of the boiler room. In the case of separate plants for lighting, heating and mechanical purposes in the larger hospitals, chimneys are ordinarily constructed by companies specially organized for this work. In the case of vents the plastering of the inside of the vent flues is sufficient for all purposes. The lining of these vents with other material will be more fully dealt with in another chapter

Roof.—As a rule the roof should not be of a slanting character, for the space which is under this portion, and which is usually an attic, can be better utilized for practical purposes by expending the money that such a roof would cost to carry up another story. In this case an ordinary flat roof would be put on to this additional story. Sightly parapets and even pediments can be run over the top and made artistic while serving their purpose. These, however, are matters which must be left entirely to the good sense and judgment of those in charge and to the architect employed.

Furring.—In fireproof buildings there should be no furring except of a fireproof character. The hollow brick now on the market is little or no better than the ordinary common brick, so far as furring is concerned. The lining up of all outside walls with gyp-

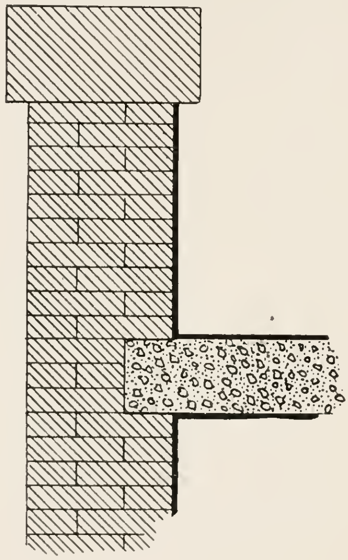


FIG. 26.

sum products is also too expensive and is not absolutely trustworthy, as they are all subject to absorption.

A word might be said here as to the general aspect of the exterior of the building. As stated before, this should be neat in design and as artistic as possible. Some artistic ability must be displayed in even the simplest of these structures, with no more expenditure than an ordinary building would cost. It is wrong to suppose that environment, especially the exterior, has no effect whatever upon the patient. For a hospital well located with lawns and trees about it, and having the general appearance of a homelike institution, or even a large residence, will often attract people who would under no other circumstances go to such a place. It has also its mental effect as well upon the public at large.

The material for the exterior of such buildings, as stated

above, must be left entirely to the architect, but under no circumstances, except as stated for general artistic effect, should any vast sums be expended on this part of the building. All unneces-

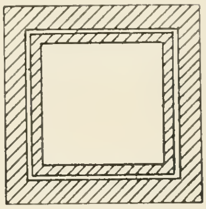


FIG. 27.

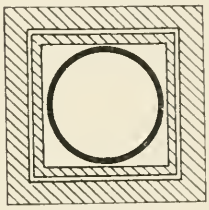


FIG. 28.

sary embellishments in the way of balconies, turrets, dormers, should be strictly avoided except in exceptional cases.

To sum up, the masonry of a hospital should be the best and the simplest; should be damp resisting, and in appearance artistic, but not ornate.

CHAPTER XII.

CARPENTRY.

In giving the details of the carpenter work necessary in hospitals it must be borne in mind that all classes of such hospitals must be taken into consideration; those which are wholly fireproof; those which have fireproof construction, and whose interior trim, etc., are of wood; and those in which the entire construction, except the outside walls, is of wood; and those which are built completely of wood. Of the latter class no special mention need be made, and the items here given will cover all cases that may arise.

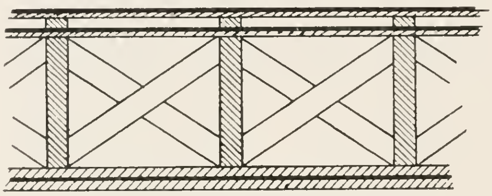


FIG. 29.

Those portions of carpentry work which are not described here will be fully treated elsewhere.

FLOORS.—The wooden floor construction used in buildings would apply to hospitals, and is such as is used in ordinary practice. Where floors of wood are laid, extreme care must be exercised to use an approved system of deafening, so that no sounds will travel from one story to another. The old method of plaster-

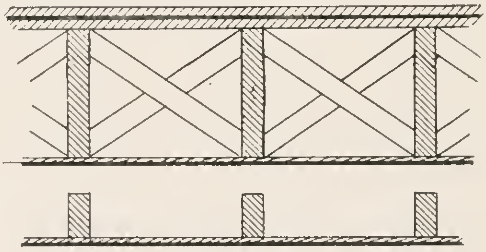


FIG. 30.

ing and back plastering (Fig. 29), or putting on a false construction for the ceiling, and leaving the floor joists to support the floor only, will not suffice (Fig. 30).

The deafening itself must be taken care of between the rough

floor and the finished floor, and must be of such character that it is not only sound proof, but also vermin and dust proof. No attempt will be made here to describe the methods of deafening, as there are many such in use, and undoubtedly all architects are familiar with them. One method is illustrated here, however, because it has been found exceptionally successful and is probably the simplest in form and application (Fig. 31). As will be noted

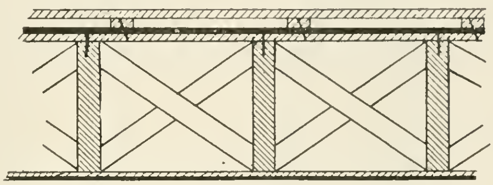


FIG. 31.

the furring strips which are placed over the deafening are not on the same centers as the floor joists, but are placed about one inch from them. This is done so as to avoid the driving of nails through the strips and into the joists, and in this manner making a direct path of travel for sound on the principle of the telephone. The deafening material can be one of the many forms now in use

The floors for the different portions of all hospitals have been a matter of dispute for many years. After thorough investigation the authors have concluded that the matter is one which will always be open to discussion; that the methods for laying floors, and the materials for same herein described, are, in their estimation, and from the use of same, the best fitted for their respective purposes. If the hospital is of fireproof construction, then no matter what the floors may be, whether of wood or one of

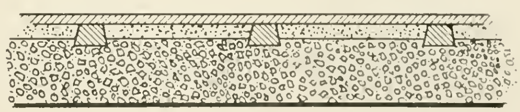


FIG. 32.

the many compounds now on the market, or whether of cement, marble, or glass, the vital point to be considered is not the material primarily, but the method and care with which they are laid. In laying wooden floors over fireproof floors the bevel strips for nailing these should be of such shape that they will be firmly imbedded and remain so (Fig. 32). There are probably very few buildings now in existence in which the laying of these strips has been done with any degree of care. Too often they give rise to creaking, unevenness, and all the attendant ills of wooden floors. They are usually laid in the wet concrete and a deafening of cinder concrete put between them, and gallons and gallons of water

are absorbed by them, immediately causing the strips to swell, and a consequent pushing aside of the concrete itself and also of the deafening. When the entire mass is dry, and the strips have dried out, as they necessarily must, they are found to be loose.

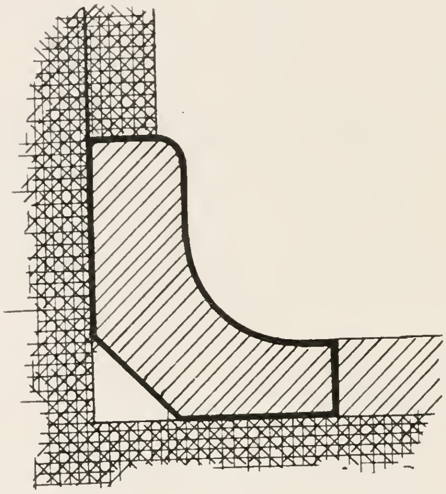


FIG. 33.

We paint the back of trim for buildings so that it will not shrink, check or warp. We give priming coats of paint to almost every part of a building, even including the iron work, so that no harm may come to these portions of the work, but in very few

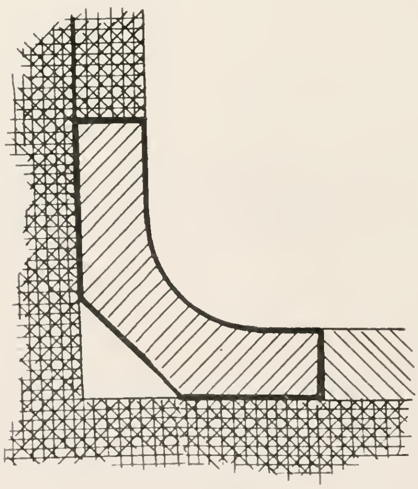


FIG. 34.

instances do we ever give any attention to the floor strips. These should either be primed thoroughly or oiled, or should be treated with some of the many fireproof compounds now on the market; they should either be thoroughly creosoted or be given a good coat of tar or asphalt. In laying finished floors on these strips after

the deafening is put between them, extraordinary care should be taken so that the work is done in the best manner. The "driving up" of the ordinary tongued and grooved flooring is too often carelessly done, and in consequence the floors are not as perfect as

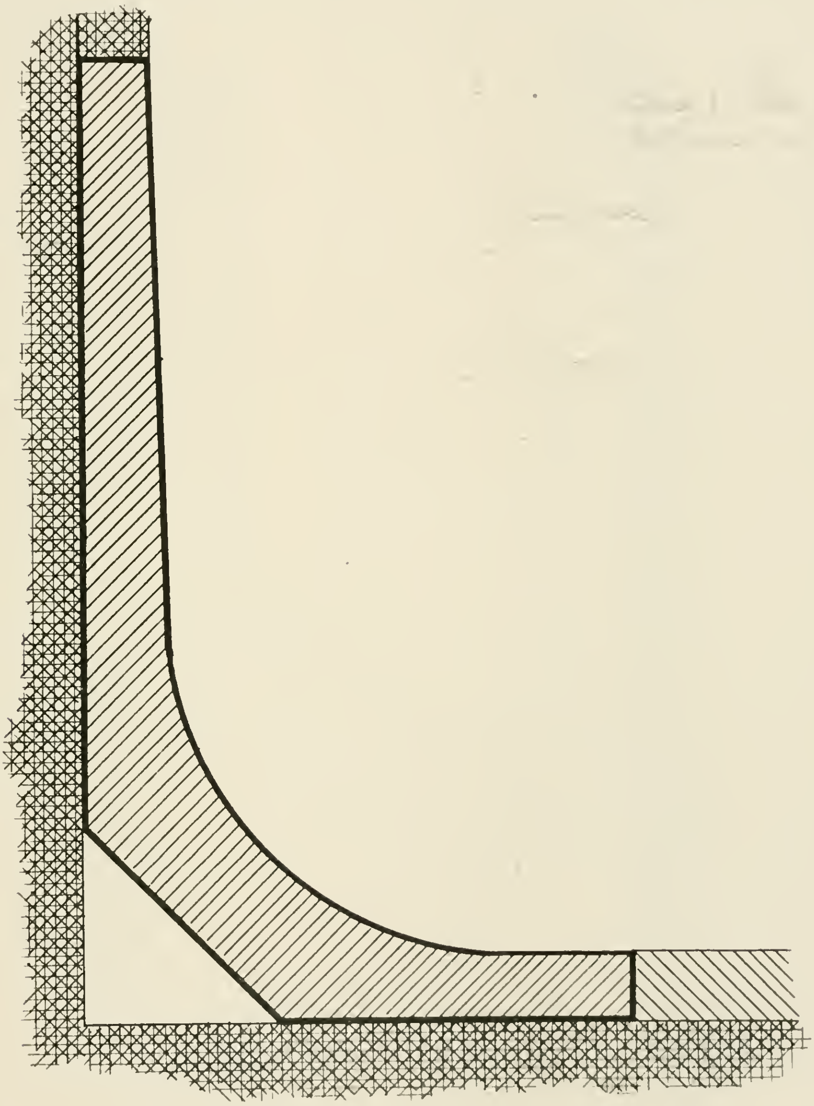


FIG. 35.

they should be. It is needless to say that for wooden floors of this character nothing but the close-grained wood should be used, maple having been found the best for the purpose.

COVES.—If the floor coves to which these are laid are to be of wood, the joint between the floor and the cove should be carefully made, so that there is no possibility for the lodgment of dust. The matter of coves will be treated separately, but a word

here in regard to the floor cove will not be amiss. If these are made of wood, as stated, one of the designs as shown in Figs. 33, 34, 35, 36 can be used. The method shown in Fig. 37, of putting the cove into the room and a quarter-round from the cove to the floor is absolutely wrong, as the primary object of the cove is de-

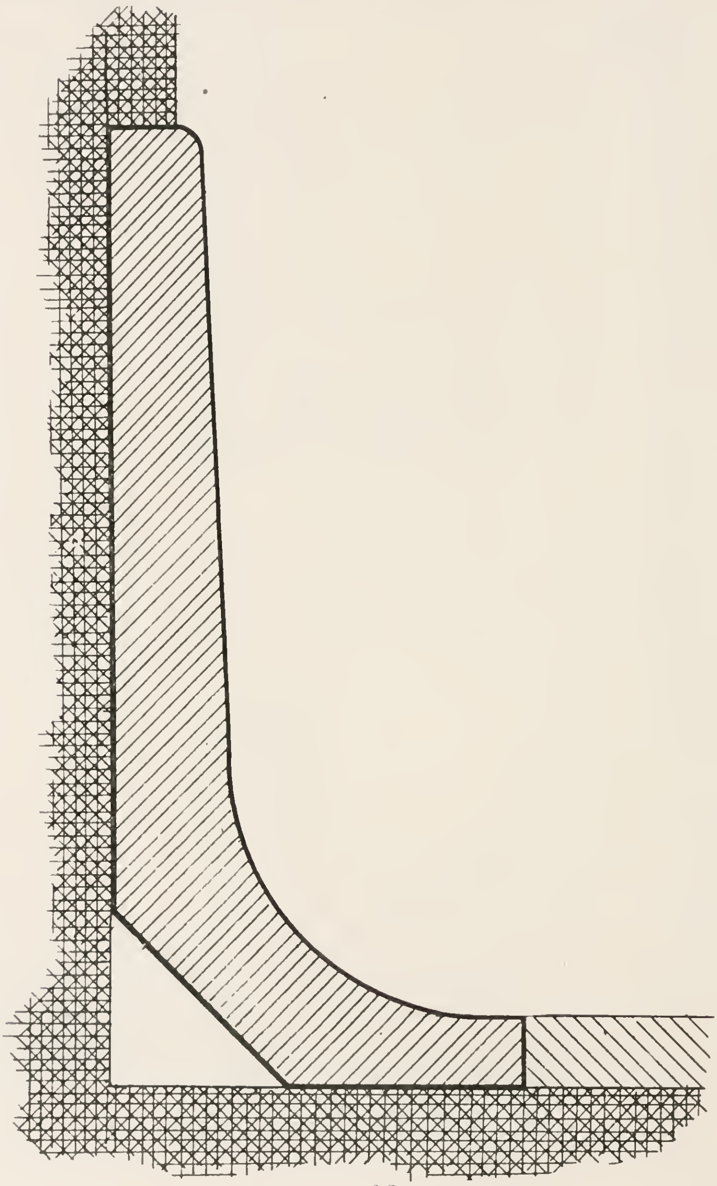


FIG. 36.

feated, making a sharp corner for the lodgment of dust and particles.

The matter of floor construction with materials other than mentioned will be treated separately under their respective heads, and will be found in the chapter on marble, mosaic, tile, etc.

Doors.—With but few exceptions for some time to come, the ordinary wooden door now in use in all hospitals will be the model, as very little attention will be given to developments along this line. While the paneled door for artistic effect may be the most desirable in institutions, it cannot of necessity be the best, owing to the multitude of places for the lodgment of dust.

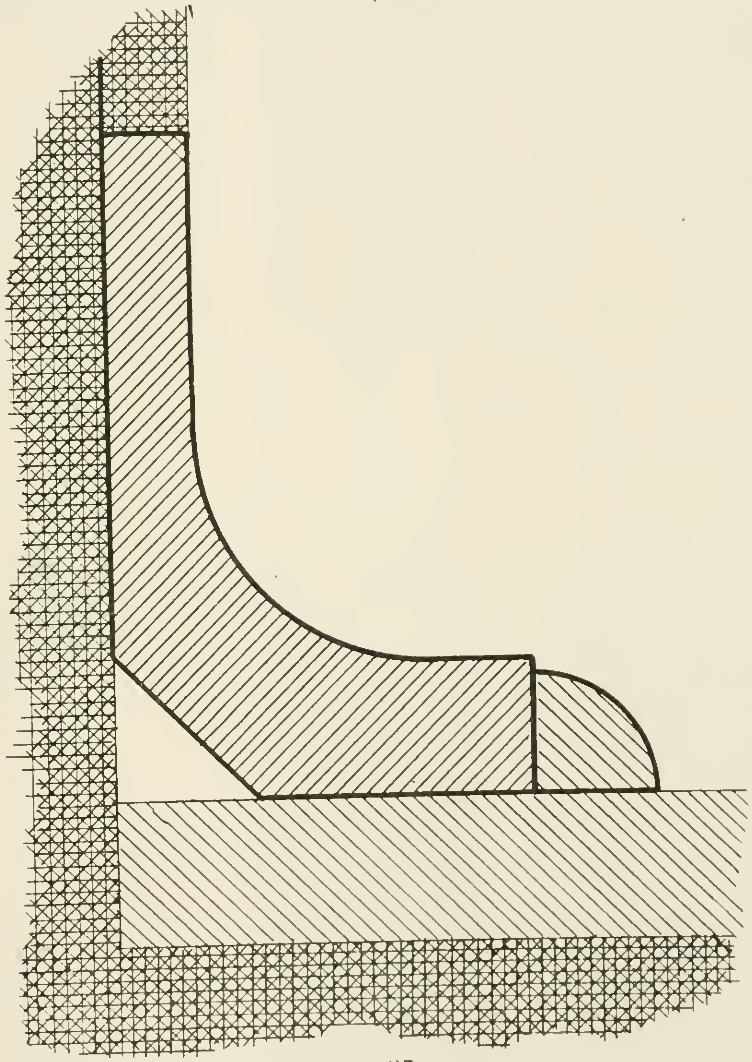


FIG. 37.

The section of a door shown in Fig. 38, where the mold has all outfacing surfaces, and where the lodgment of dust is reduced to a minimum, would be the best form to use, if paneled doors are necessary in the estimation of either the architect or the committee which is building the hospital, from a purely esthetic standpoint. The development which hospital construction has made has necessitated the study by manufacturers of the entire inside

finish to such an extent that there has been put upon the market a door without panels, made in such a manner that it is more durable than any other kind. This is either a five or seven-ply door, or a cored door (Figs. 39 and 40). The finishing of these doors

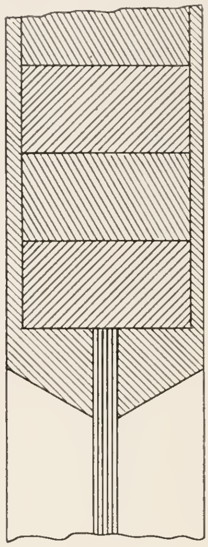


FIG. 38.

with oak or any hardwood veneers, and the artistic application of fillers and varnishes, make them far superior to anything so far attempted in this line, both as to merit for the purpose intended, as well as artistically.

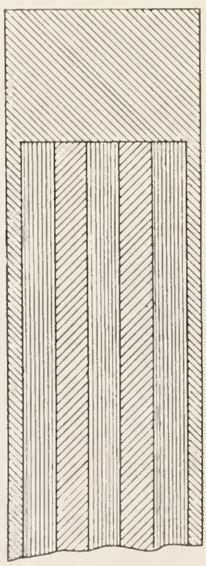


FIG. 39.

In some hospitals a particular effort has been made to eliminate all angles, not only in doors, but at all other points. No doubt

there is an advantage in this, if it can be accomplished without detriment to the appearance of the rooms, and provided also that it does not greatly increase the expense of construction.

There is a partly scientific idea which accounts for this feature—dust contains microbes; irregularities upon the surfaces favor the accumulation of dust; microbes cause disease, hence we must prevent any possibility of dust accumulation in order to prevent the collection of microbes, thus eliminating the transmission of disease. Superficially this sounds logical, but we have omitted one of the important factors; it requires contact with these micro-organisms to cause disease, and as they are not good travelers, they would require several centuries to progress from the irregularities to the patients. Consequently such irregularities cannot of themselves be considered as harmful.

The primary reason for making as few angles as possible where dust could collect is one of cleanliness. No one can doubt

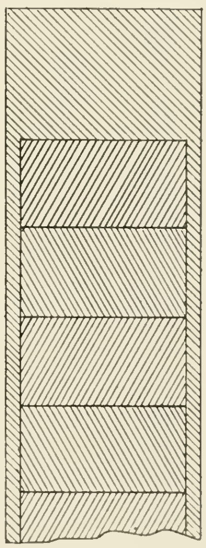


FIG. 40.

that a door without molds is much to be preferred on this score alone. doe

In fireproof hospitals, however, it seems that some form of door should be put in that would entirely isolate the rooms from the corridor, and also from one another, in such a manner that if a fire started in any given space it could be confined to this space absolutely. This would, of course, necessitate the elimination of the wooden door entirely; also the trim and wood transom with the ordinary glass. There are now on the market metal-clad doors, which are made very artistically, with or without panel. The transom can be glazed in wire glass, and while this would not be a fire preventive, it would be a fire retardent. These metal-

clad doors are made of wood inside, covered with sheet metal and finished to resemble an ordinary wooden door (Fig. 41). In the Baltimore and San Francisco fires these doors were found to be thoroughly capable of excluding fire from given spaces.

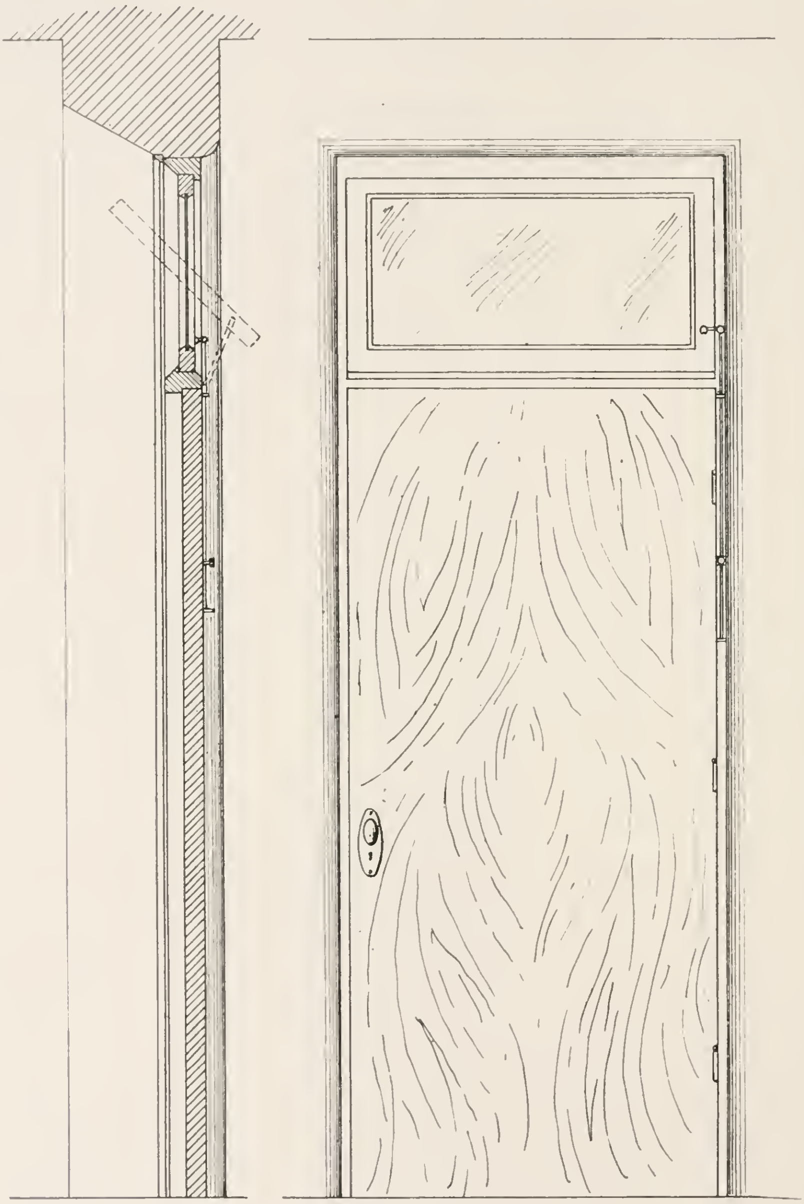


FIG. 41.
Section Elevation.

The efficiency of these doors to exclude fire—in other words, their fireproof qualifications—is due to the fact that they are seamless. The rather surprising point in favor of them, aside from their fire-resisting qualities, is the fact that they are no more

expensive than good hardwood doors. They can be put in, either where single or double action doors are used ordinarily. Their particular usefulness, however, manifests itself in the closing off of all stairwells, elevator shafts and the like. Such doors in partitions between elevator shafts surrounded by stairways where there is positive isolation is of particular advantage, of which an illustration is given here (Fig. 42). As will be seen on the plans for

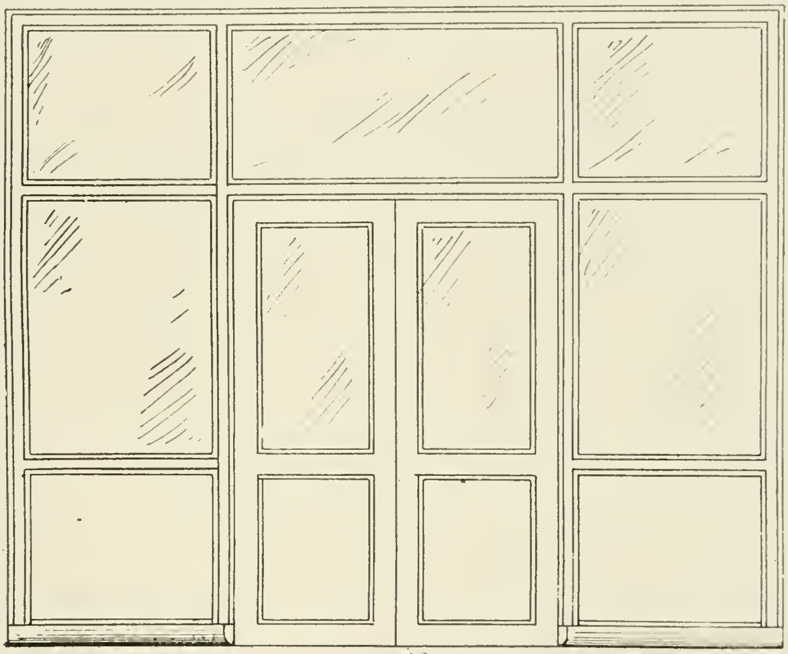


FIG. 42.
Metal Clad Partition.

model hospitals, illustrated in this volume, this would absolutely cut off the stairwell and elevator shaft from corridors, and do so in a fire-resisting manner.

However, if there is an objection to this method of surrounding such spaces, another may be employed, which is probably as efficacious, although it would not be as economical—namely, to make angle iron frames in the entire opening. The frames can be divided, as is shown in the illustration (Fig. 43), with black iron sheets riveted on, and having the doors made of angle iron and filled with wire glass and black iron panels. The iron panels riveted on, would of course, be much more costly than the metal covered door, and while it might be sightly, it is doubtful whether it would give the pleasing effect of the latter.

It is an absolute necessity that the double action door be employed in every possible instance. This is especially true of spaces that are used continuously. Where double action doors are used, and where such doors are single instead of in pairs, care should

be taken that glass be put into the upper portion, as shown in Fig. 38, to prevent the possibility of collisions. This can be either chipped or maze glass. Where persons are coming from opposite directions to go through such a doorway, a shadow on the glass gives warning of the approach of either one to the other.

Door frames, except in rare instances, should not be incorporated into the building. Where they are put in, and in such instances as it is impossible to put in a splay, they should be perfectly plain and can be metal clad as for doors. In all other instances the jamb should be splayed, as shown in Figs. 44 and 45. The head need not be splayed, however, as it is somteimes impos-

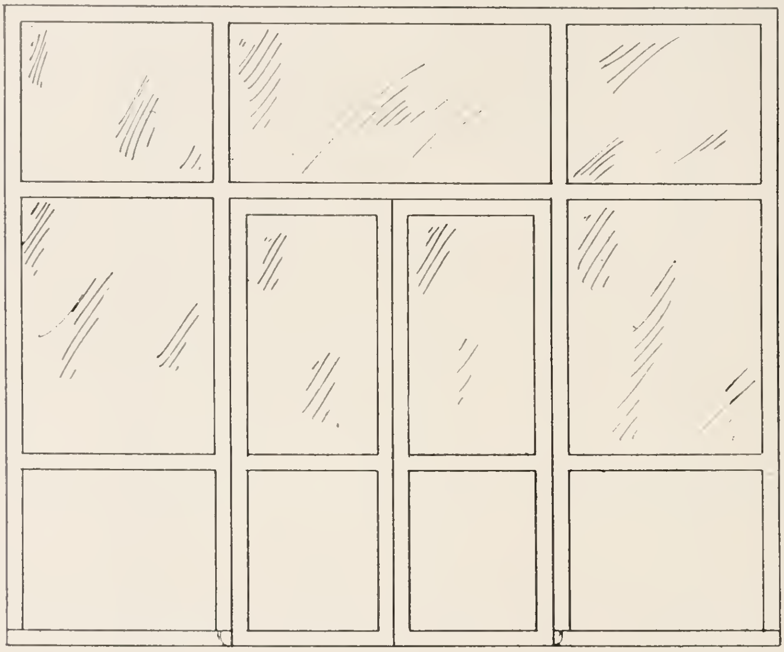


FIG. 43.
Angle Iron Partition.

sible to do this on account of lack of head room, owing to constructive details. Such a head is shown in Fig. 46, the jambs being splayed, leaving as little space as possible for a bed mold, which can also be of fire-resisting material, as described and shown (Figs. 47 and 48). The manner of putting in base blocks to catch floor coves is shown in Fig. 49.

Transoms.—In cases where transoms are hung over doors, the same care can be taken in avoiding material that will burn, and as stated before, these can also be of metal-clad material, or of angle iron frames, and have wire glass. It would be well if some method could be incorporated by which these transoms, in case of fire, could be automatically closed. Transoms should be

hung in such manner as to facilitate automatic closing, but if this is not done, the center-hung transom is preferable (this to be operated by the ordinary transom lift), as it augments ventilation (Fig. 41).

WINDOWS.—In the treatment of windows for hospitals it is not necessary to go into detail as to the methods of installation, but attention is again called to the fact that the fireproof window frame sash, either of the all-metal variety, or of the metal-clad variety, can be used. While the source of fire so far as the win-

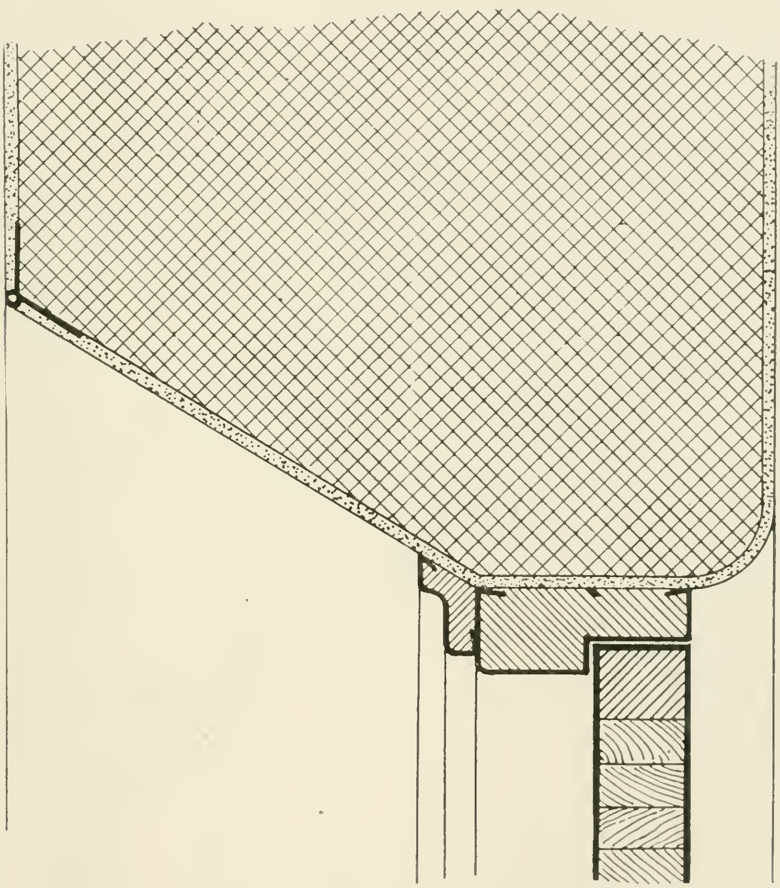


FIG. 44.
Door head without trim in room.

dows are concerned is in most cases from outside the building itself, the same care and attention to the point here might be questioned, but so long as fireproof hospitals are being constructed, and the cost is not unreasonably in excess over the all-wood construction, there can be no valid excuse for not making everything in the construction of the hospital as nearly fireproof or fire-resisting as possible.

The window sash should be hung in chains or in steel tapes

over good pulleys. The latter should not have less than two and a half inch wheels, and should be of either the smooth running, pin-bearing type, or ball-bearing, to avoid squeaking, which is one of the principal causes of annoyance to patients.

Above the second story all windows in the hospital should be of such type as are advocated by ordinances in most of the large cities in this country, so that all the cleaning can be done from the inside: the different patterns of these on the market are innumerable. Care should be taken in selecting only those which have this advantage of easy cleaning, combined with simplicity. Too much stress cannot be laid upon this latter point, as some windows are so complicated that only an expert can operate them. Fig. 50

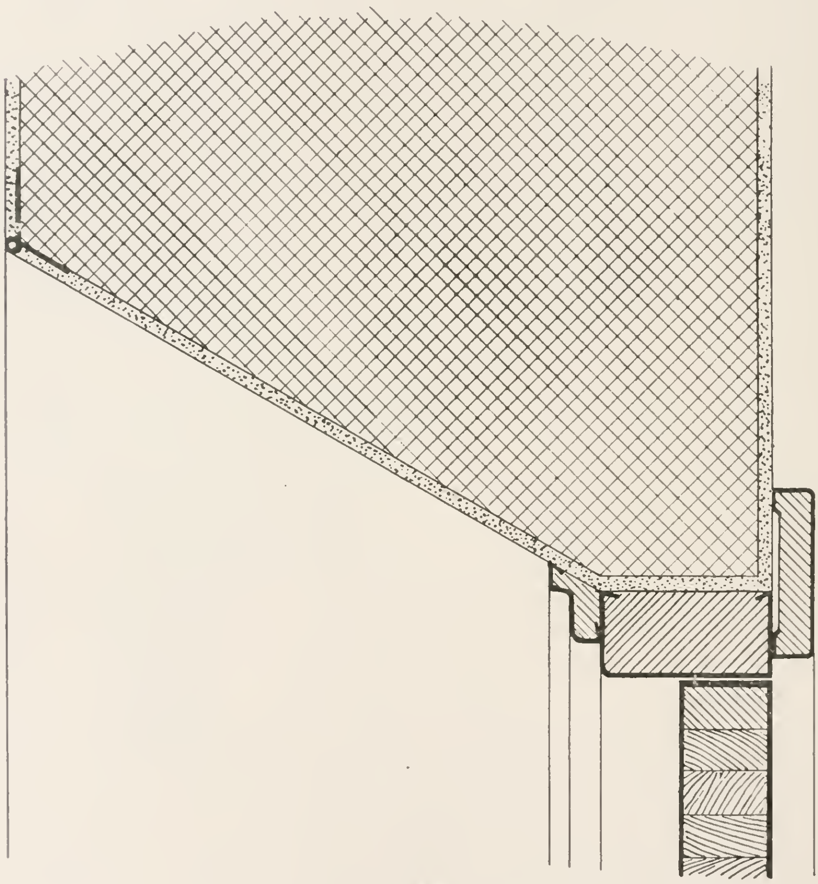


FIG. 45.
Door head with trim in room.

and Fig. 51 show windows with flat head and jambs and with splayed head and jambs, the molds being similar to those for doors of same type.

FINISH.—The inside finish of the entire building can be made in the metal-clad form, and where the building is not absolutely

fireproof, should be of close-grained wood, if possible, and if not, should be of oak, well filled and varnished or enameled, as will be described under Painting.

The trim, some forms of which are illustrated here (Figs. 52, 53, 54), may be metal clad or the same form in wood. The metal-clad trim can be made to represent any wood desired, which, in itself, is a recommendation, inasmuch as rooms can be finished differently, especially those for private patients, and a different scheme of decoration used throughout the hospital. In putting the trim on windows, the same care should be exercised in doing away with as much of it as is possible. There should be no wooden sills

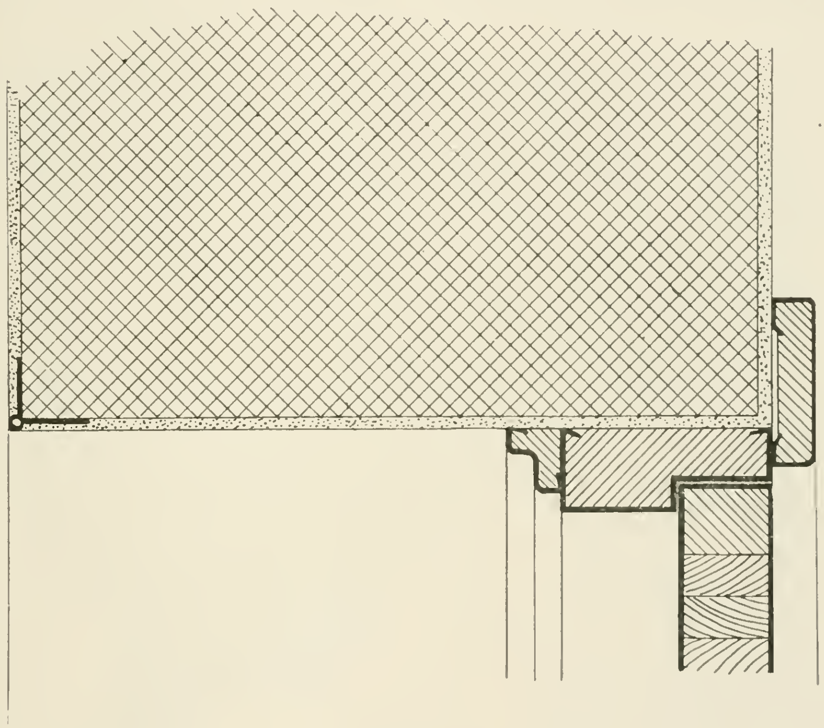


FIG. 46.
Door head, trim in room, square head.

in the building. Either a splay should be used with a corner bead around the entire window, as shown in Fig. 50, or there should be a flat sill not less than $1\frac{1}{4}$ inches in thickness, made of either marble or some variety of slate, all of which are obtainable (Fig. 51).

If possible, there should be no base in the rooms, but the cove in the wall should meet the floor on a flush line, as shown under Floors. If the floors are of wood, these coves could be made with the plaster running to them, or can be of wood also, as shown in Figs. 33, 34, 35 and 36.

Picture Molds.—In all rooms, where possible, picture molds can be run, except in contagious hospitals and in children's hos-

pitals. In all other hospitals these picture molds can be made of the metal-clad material, or not, as desired, there being so little it would make no material difference in case of fire.

PARTITIONS.—All partitions dividing spaces, such as in corridors and other rooms, can be made to follow the same lines as those laid down for stairwells and elevator partitions.

STAIRS.—In the non-fireproof hospitals—that is, those for smaller towns, where it is not expedient, owing to lack of funds, or for other reasons, to build an absolutely fireproof structure—the stairs would necessarily be built of wood, but even such stairs

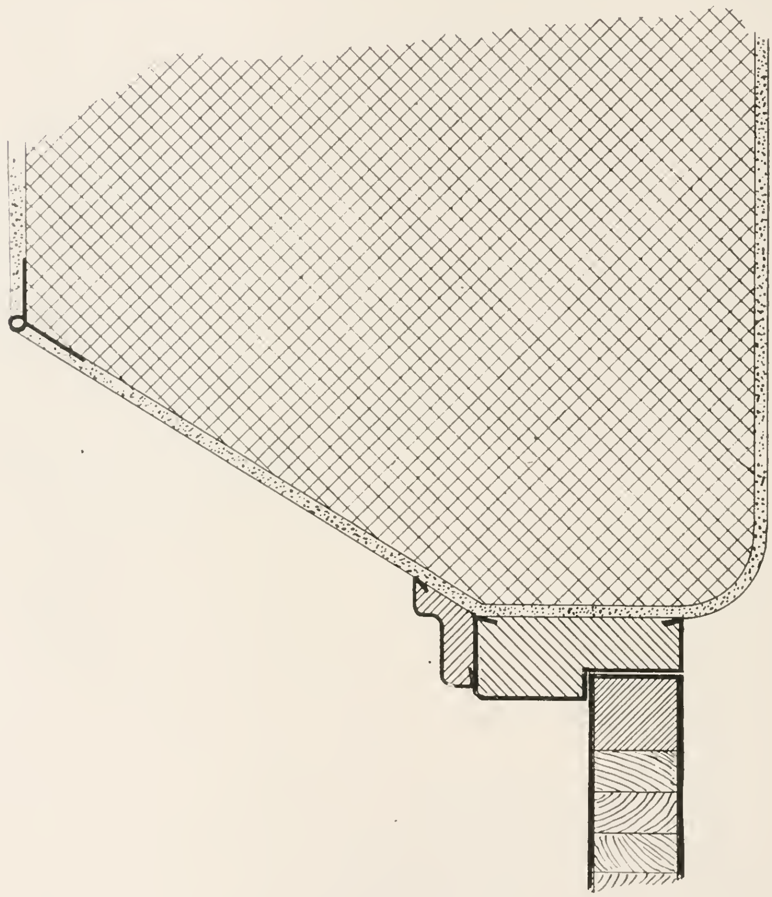


FIG. 47.
Plan of door without trim in room.

can be made in such a manner that they are to some extent at least closed off from the remainder of the building, and protected, primarily, so that in case of fire, egress from the building can be effected by them. This can be accomplished by using, instead of ordinary wood lath, the wire or expanded metal lath, with cement plaster, which, while it would in no sense make fireproof stairs,

would be a fire retardent, if sufficient stops were put in at close intervals on the height between the studs. This is often sufficient to give time for every one to escape from a building of this character, should the occasion arise. It is to be supposed that there would not be any more than two flights of stairs from the top to the lower floor in any hospital of wood construction. The surrounding of the stair well by a brick wall would, of course, be the best method to employ, no openings being left in this except the windows to the outside and the doors into the corridors, these latter being double action, to be of either the metal-clad variety or of the angle-frame variety, as mentioned herein.

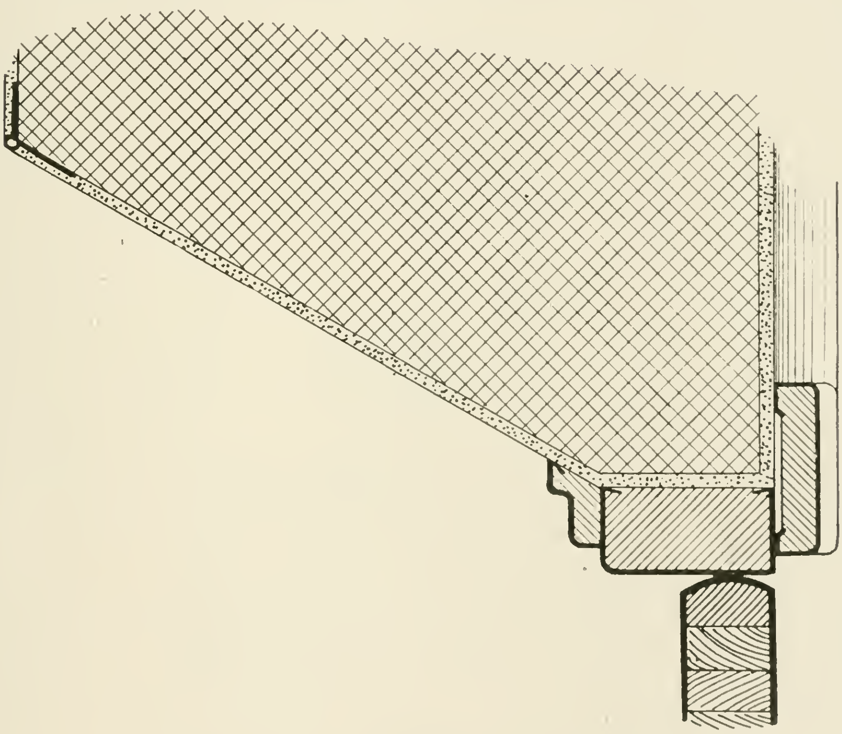


FIG. 48.

Plan of door with trim in room

In fireproof hospitals little need be said of the stairs, as this feature will be fully covered under the head of fireproofing, but the method employed in some hospitals of making the entire building fireproof, with the stair stringers of iron and the risers also of the same material, and then putting in wooden treads, is vicious and to be deplored. If this is done from a sense of economy, even in eight or ten story buildings, it is inexcusable, as economy should be practiced elsewhere in order to use fireproof treads on such steps. If it is for the purpose of lessening noise, it may be said here that if a hospital is properly constructed, and the stairs are

isolated, as is demanded in most of the large cities now, such an excuse is not to be considered.

In general it may be said that too little attention is given to the matter of easy runs on stairs. In order to make them so, landings should be provided. If space is to be sacrificed, it is usually taken from this portion of the building. Another point to be mentioned is that all stairways should be constructed in such a position as to have outside light.

PORCHES.—In non-fireproof buildings there should also be built large verandas, and, if possible, these should in all instances be fireproof. This can be done very cheaply with reinforced concrete, or by an all-iron method, which is frequently employed. From these balconies there should lead from floor to floor, and

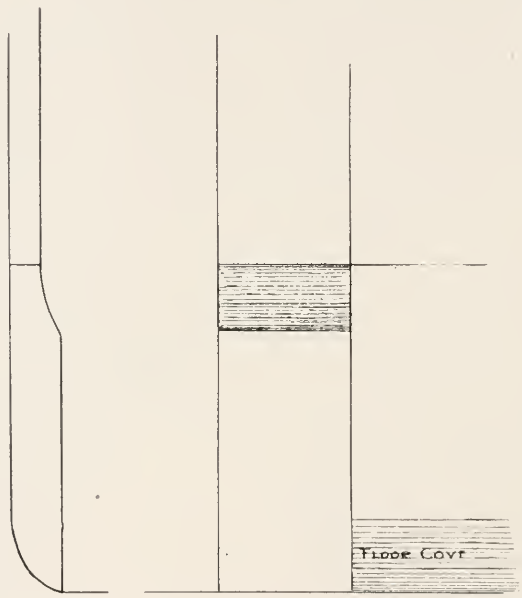


FIG. 49.

Side. Front Elevation.

Showing base block where trim is used on openings.

to the ground, a wide stairway, so that a patient could be carried from a floor where a fire occurs to any one of these verandas, and then down the stairs to the ground, safely and rapidly and without dangerous exposure. Too much stress cannot be laid on this subject of verandas in such hospitals; in fact, this may apply to almost all hospitals, whether of fireproof or non-fireproof construction, as in many instances these could be used for solariums for convalescent patients.

CASES.—Special care should be taken in the designing and constructing of cases for pantries, kitchens, linen closets, instruments and medicines. They should be made in such a manner as

to be susbtantial, but should not be in large sections, nor should they be permanent fixtures, but in all instances be made of the

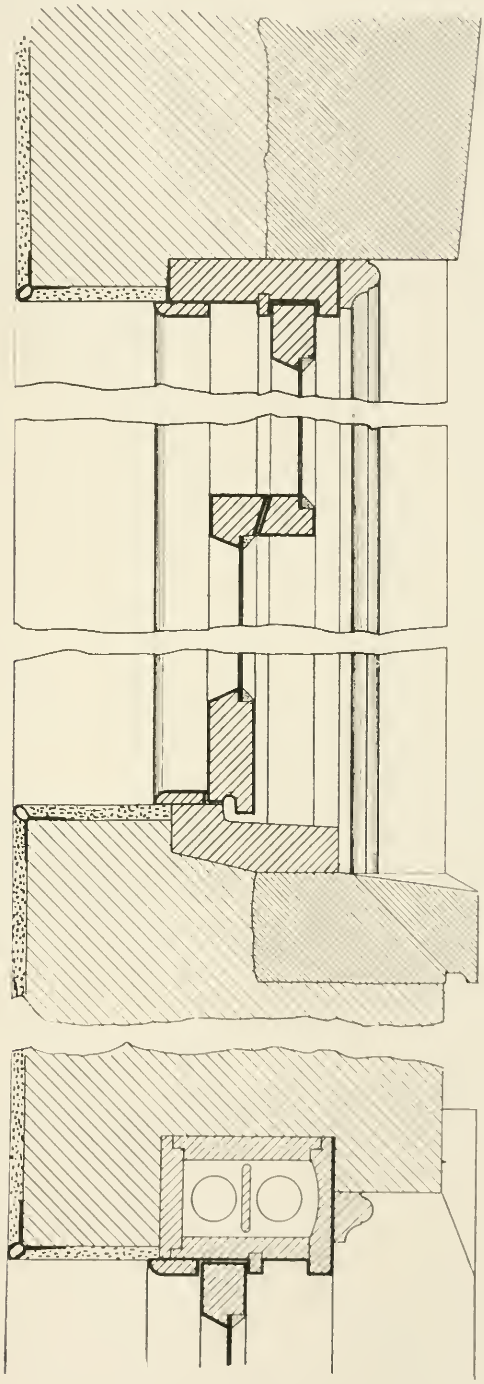


FIG. 50.
Section in elevation and plan.

"knock-down" variety. If it is necessary to clean behind them, as is often the case, or there is any change in the arrangement of

the hospital which would call for their removal to another location, such conditions could be met with the greatest facility. It

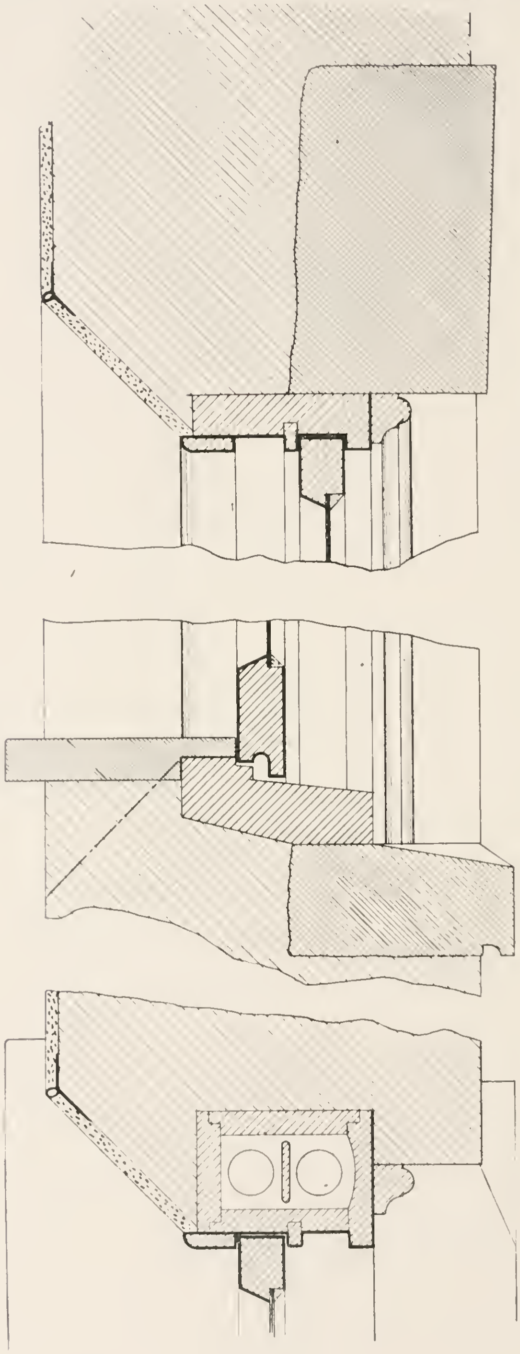


FIG. 51.
Section in elevation and plan.

seems that it would be a very feasible plan to construct these cases on the expansion method, as is employed in making bookcases.

They could then be made at all times to meet the requirements of the hospital in its development.

No specific detail can be given for such cases, nor can rules be laid down for their exact use: this must be left entirely to the architect, who has had experience in designing such items, so that

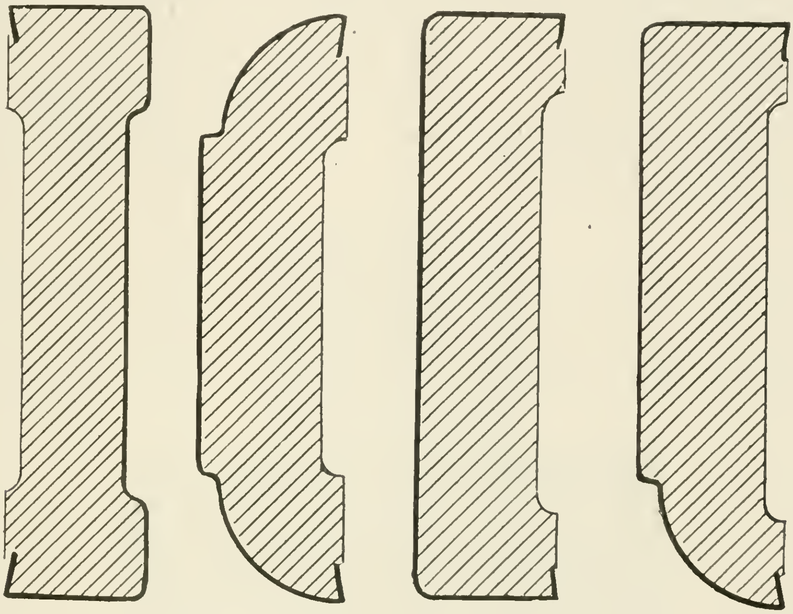


FIG. 52.
Trim.

they may be of the required form and type and size. There are no two instances in which conditions are precisely the same, for much depends upon the general management of the hospital itself; but this need not preclude, in any manner, the possibilities of the ex-

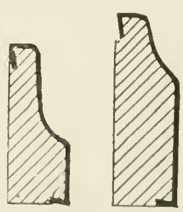


FIG. 53.
Stops.

pansion system. The vital point to be considered, however, is that the cases should be of the simplest kind, so constructed that they are readily cleaned from inside and outside, and that in all instances they be regarded not as parts of the building, but as accessories or furniture. This may not seem expedient in the building of pantries, but a little thought on the subject will show

that it is necessary in these places as in no other portion of the hospital.

LOCKERS.—The same principle follows where lockers are

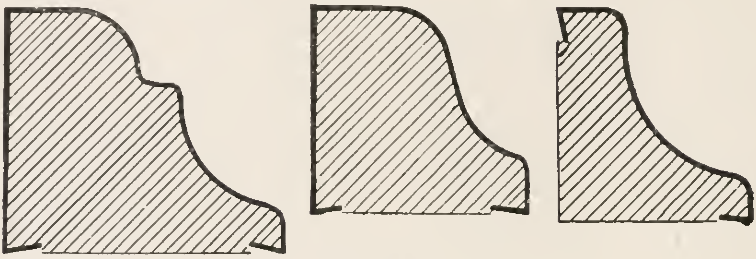


FIG. 54.
Bed moulds.

"built in." Such method of constructing lockers is particularly to be condemned, as there are few instances where these built-in lockers do not become unsanitary, even with the best of care. They cannot be constructed by the ordinary carpenter in such a

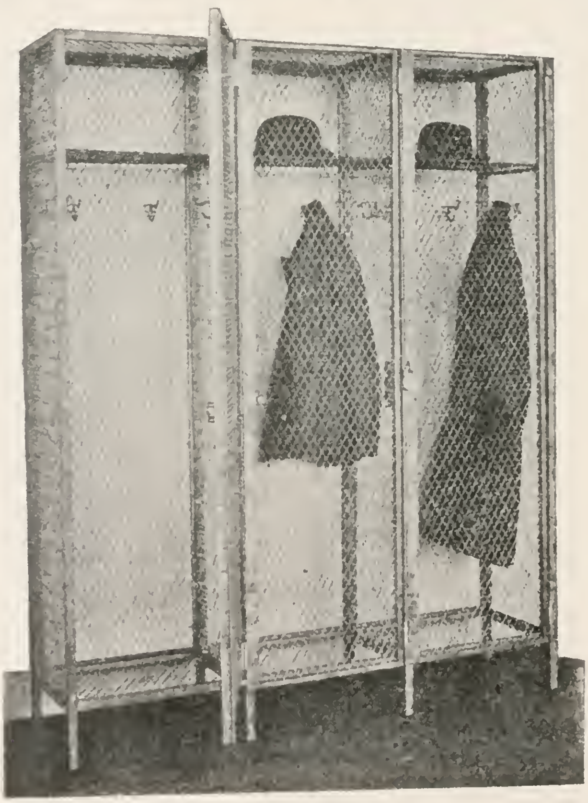


FIG. 55.

manner as to be irremovable and sanitary at the same time. The only locker worthy of consideration in any hospital, be it a fire-proof or non-fireproof building, is an all-metal one, whether this

be of the open type—namely, the wire mesh type, as shown in Fig. 55—or of the closed type, as shown in Fig. 56.

All of these have their advantages, as they are built with a view to ventilation and sanitary conditions. The closed type form of metal locker, known as the "knock-down" type (Fig. 56), is probably one of the best on the market to-day, inasmuch as it can be taken apart in a few moments, thoroughly cleaned or renovated, and put together in the same space of time. These lockers are made with the enamel burned on, which, with ordinary care, should last for many years. It is wrong to suppose that a locker room should be one that can be used for no other purpose because

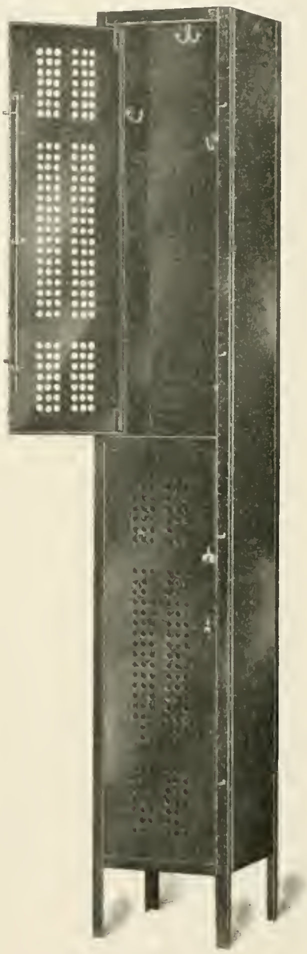


FIG. 56.

it is dark and out of the way. It is as necessary to have sunlight and ventilation in this as in any other room in the building; in fact, it cannot be too strongly advocated that this be the rule rather than the exception.

Hardware.—It is not necessary to go into a lengthy explana-

tion of the character of hardware to be used throughout a hospital, as it would be self-evident to most every one that the simpler this is the better. It is necessary to mention, however, that the hardware should be of the very best, as only this kind is capable of withstanding the constant cleaning which is required in all parts of such a building.

CHAPTER XIII.

FIREPROOFING.

A building which is made of fireproof material and is surrounded by buildings of like construction is the most desirable kind for any purpose. This is true of all hospitals, but especially so of those built in congested localities. However, this condition is not always to be obtained. The primary consideration of having a hospital isolated as much as possible cannot always be carried out, so that as an extraordinary precaution such buildings should contain a minimum of combustible material, and the utmost care should be exercised in the incorporation of the fireproofing.

Fireproofing is a very much abused term, for ordinarily it is construed to mean "anything that does not actually burn."

There is undoubtedly inferior fireproof material on the market, but this must not be entirely charged against the manufacturer, but should be against the users as well. The demand invariably controls the supply in cases of this kind, and there are those who will ever be prepared to supply just so much as people will pay for and no more. Tile floors and tile partitions; concrete floors and partitions of the same material; or partitions of some of the many first-class fireproof materials, when properly made will apply to all of the possible problems which could arise. The fault is not in the principle, but the manner in which it is applied.

If hospitals were constructed with speculative intent there would be some excuse for slighting this important feature, but it is a recognized fact that this is not the intent of such institutions. Again, there are those who "build only as well as they are compelled to by law, or by rules made by those who indemnify in case of loss." If there is any class of building in which these faults are to be avoided, it is in hospitals. Fireproofing in such institutions should mean all that the word conveys, not only as a protective measure itself for the building and for the patients within the building, but as an absolute moral obligation.

No one can doubt the efficiency of the better types of fireproof construction. The term in itself—that is, fireproofing—is so broad that it is almost useless to attempt to define what fire protection

is, and the subject may be roughly divided into three classes as follows:

First—The organization of fire companies, which are usually maintained by the public for the protection of its buildings.

Second—The construction of the building in such a manner that it will resist and withstand the effects of fire.

Third—The apparatus which is usually put into buildings, but which is not necessarily a component part of them, for use in case of fire.

There is no need of going into detail concerning the first of these divisions, for very evident reasons, and anything like an exact or comprehensive review of the third division could not be made in a book of this kind. In this latter division such devices as are ordinarily used will be mentioned. Of these, the standpipe with hose extension and the different fire extinguishers of chemical pattern are the principal ones.

The second division—namely, fireproof construction pure and simple—in its many phases and forms, is given here in a contracted form, for the principles involved are those which the architect ordinarily would follow from specifications written for such systems.

We find many hospitals constructed in the ordinary manner without the least attempt towards the safety of the patients in case of fire. In these every precaution is taken and every device known to the professional man is incorporated for the care of such patients during operation and subsequent residency in the institution, but no thought is given to the fact that in the event of fire, and the panic which usually follows, instead of having one patient at the time to care for, they all must be handled and often removed from the building in an incredibly short space of time. Institutions have come under the observation of the authors which have been considered model in every respect, and which did not have the semblance of a fire escape or even a fireproof porch, or, for that matter, a porch of any character, to which patients could be removed and then taken to the ground. In many of these there was no way of egress whatever except by one narrow stairway. It is safe to say that over seventy-five per cent. of the hospitals now in existence are of this character and type.

It is peculiarly characteristic of municipalities that regulations are made for theaters and even for office buildings, as to their safeguarding of the public, when in buildings of this character the people are at least able-bodied and capable of taking care of themselves, even in time of panic, whereas, except in the largest

cities, there is no provision whatever made for such safeguarding of those who are entirely helpless in case of fire.

Fireproof Material.—Materials of this character such as will not themselves burn, will resist the action of fire and protect the structural parts at the same time. An example of this will suffice. Cast iron will not burn, but under the action of fire will bulge and warp and thereby cause great damage. even to the extent of the wrecking of a building.

There are two ways by which fire spreads over an extended area, horizontally and vertically. To prevent the horizontal spread, all walls and partitions should be built of incombustible and fireproof material, and any doors or windows in these walls should be equipped with fire-resisting or entirely fireproof devices. Fires which progress in other directions are overcome by building the floors of fireproof material and making them continuous. The stair wells, elevator shafts, pipe slots and other continuous openings in a vertical direction should be built with brick, tile or concrete walls, thus isolating them respectively. All openings in these shafts should have fireproof doors or windows, as the case may be. It must be borne in mind that not only the shafts themselves are to be built of fireproof material, and the openings protected as stated, but that every part of such portions of the building must be treated likewise.

The materials for fireproofing, the method of installing these materials into buildings, and the necessary devices aside from those that have already been mentioned, are of great variety. These include floors and partitions of tile, concrete, plaster and expanded metal in its different treatments. Each has its various ramifications and methods of installation. The manner in which these are taken up in this volume does not imply that they are to be so ranged as to their respective merits.

Concrete.—It will be necessary to state in connection with concrete construction that the various systems will not be described for two reasons: First, there is such a multitude of these and the variations are so great that it would be impossible in a volume of this kind to go fully into them, nor is it necessary to do so, except as illustrating the methods, as the many text books on this subject and the catalogues of the individual systems fully describe them. Second, the requirements of municipalities preclude the possibility of describing any system at length which would fulfill all building laws, as there are such vast variations in these laws. It may be stated here in reference to the second of these conditions that it is not safe to follow such building requirements, as they are usually far behind the times as regards con-

struction, and ordinarily are made by men with no technical knowledge which would enable them to draw up the proper specifications.

Moreover, when building laws are made and passed it takes considerable time for them to be enacted, and by the time they are enforced, improvements will have been made which render the requirements in many cases obsolete. In other words, progress in this form of construction is so rapid that a year will make a vast difference in the form.

Concrete is beyond the experimental state as a building material so far as its reinforced qualities are concerned. As in the selection of all other material, so here extreme care must be exercised in the choice of system.

Protection.—Protection of steel in this form of work is of vital importance and must be given more than ordinary attention. In no instance whatever should there be less than one inch of concrete at any point for such protection, as most of the failures which have occurred in concrete construction have been due to the fact that proper care had not been given to this part of the work.

One of the important advantages of concrete construction, where the steel is properly encased, is the protection of the metal from corrosion. In this connection it may be stated that the use of cinder concrete is not to be recommended, for in the best form of construction in this manner there are bound to be impurities in the cinders which naturally disintegrate the iron. This is particularly true of the sulphur which is left in them by improper combustion. Gas pipes and electric conduits, water pipes and other iron ways have been known to become disintegrated to such an extent as to cause serious leaks, and by repeated experiments it has been found that this was due to the properties of the cinders themselves.

It is not safe to suppose that when quantities of this material are put into a building that care will be taken in selecting only such as are absolutely and perfectly burned, nor can allowance be made for the intelligence of workmen in throwing out such material as is not fit to be put into the work. It need not be stated here that intelligence has much to do with any form of concrete construction, for unless a good superintendent is put on the work there is liability of the work being done in a manner that will cause trouble later. While good concrete construction has been found to fulfill all the requirements of fireproofing, it is usually put in by unskilled labor, and this would of itself necessitate extraordinary care on the part of the superintendent, beyond what would be called for in some other forms of construction. While

this argument applies forcibly in this instance, it may be stated generally that while the intelligence of the average workman is not doubted in the least, the interest he takes in his work is not such that he would discriminate as to the methods.

Deafening.—What has been stated in reference to cinder concrete and the disintegration of pipes applies not only to cement construction itself, but also to any form of construction, be it hollow tile or concrete, where the deafening of cinders is put in between floor strips, as illustrated in Figs. 32, 67 and 84.

There are several methods of deafening which are fully as good as cinder concrete, although none of them has the qualification of cheapness of the latter. One of these is the use of mineral wool. This is not alone admirable sound-proofing material, for which it is extensively used, but it also furnishes the greatest possible protection from the heat in summer and the cold in winter; in other words, it has the insulating qualities. It is vermin proof, being made from slag through which a jet of steam has been blown at high pressure. There is fiber on the market also which is put on in quilt form and which will not burn. These fibers also have both insulating and deafening qualities.

Of those deafeners which are not fireproof no particular mention need be made, but inasmuch as the floors which are put over them are usually of wood and are in themselves not fireproof, this would not preclude their use in so-called fireproof buildings where such floors are used. While these are not strictly fireproof, there is no particular disadvantage in using them except from the point of view that in a fireproof building everything should be *fireproof.*

Cost.—The cost of systems to be installed depends wholly upon local conditions. If terra cotta and clay products are not available, and crushed stone or crushed slag, or washed river gravel, are available, the reinforced concrete construction would be the best to use. However, if the latter materials are not available, and the former are at a less cost, such facts, of course, would determine the system to be recommended.

PARTITIONS.

Plaster Blocks.—The use of plaster partitions when the material is of plaster of Paris is not to be considered fireproof. Plaster blocks and plaster run in forms are used in fireproof buildings, but they will not withstand the action of either fire or water. The absorption of water in such material is from 40 to 59 per cent. of their weight when in dry form. When exposed to heat, in comparison with terra cotta, brick or concrete, they are not to be considered. The plaster calcines and when wet immediately powders, so that in case of fire if such partitions or even floors were

subjected to heat and a stream of water thrown upon them they would quickly be wrecked. The drying out of such blocks is very slow, as they must be thoroughly soaked before they are set. While this same objection might be raised concerning tile and concrete, it must be borne in mind that the drying out of both of these is very rapid.

Steel Studs.—The form of partition with steel studs and furring for fireproofing are both inexpensive and practical, as in this method of fireproofing a channel bar is used, and upon this is put expanded or wire metal lath, and both sides of this are heavily coated with hard plaster (Fig. 154A). If a hollow partition

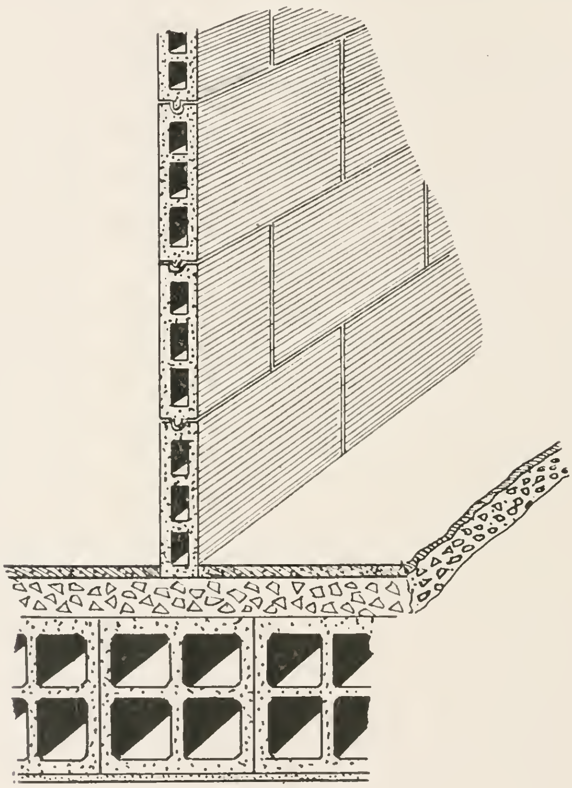


FIG. 57.

is desired these channels are taken in width of three inches and up. If a solid partition is wanted, one to two inch steel studs are used.

Blocks made of plaster of Paris and of gypsum have the same objection as stated under the heading of plaster blocks—namely, their disintegration under fire and water. These are built in either hollow or solid partition form and have one particular recommendation, and that is that they can be run or built smoothly and need but a finishing coat of plaster.

Tile.—As far as practical building material for partitions is concerned, tile has been found to be the most advantageous, both on account of its lightness, and the fact that it is absolutely fireproof. There are two forms of this partition, as shown in Figs. 57 and 58—namely, the book tile and what is commonly termed

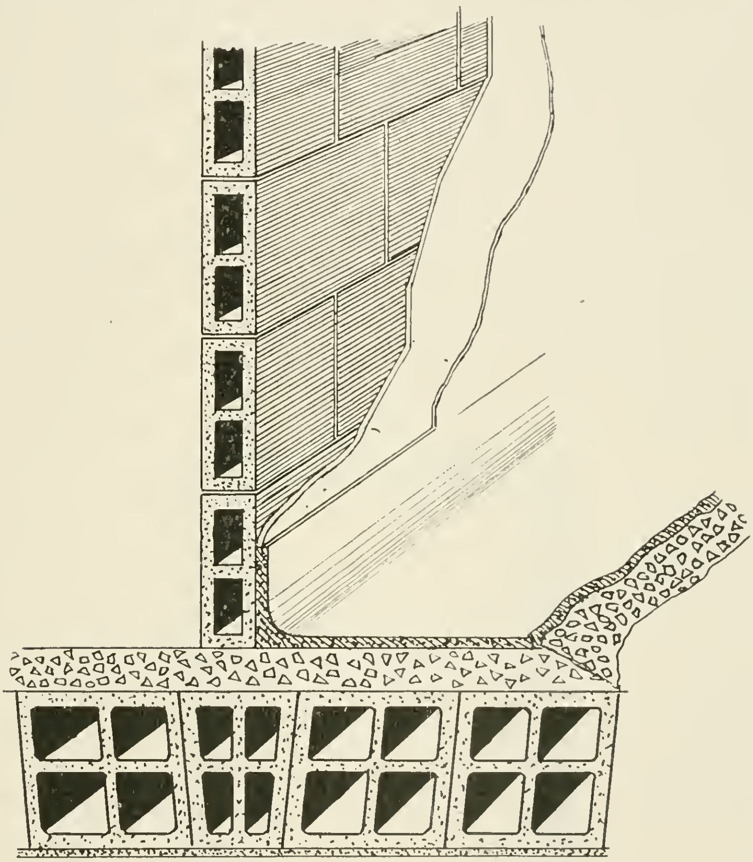


FIG. 58.

hollow blocks, all of which will be treated more fully under fireproofing with clay materials.

Safes and Vaults.—In all hospitals, be they fireproof or nonfireproof, safes and vaults should be provided. In hospitals it is necessary to make and keep records, and these must of necessity be well protected. It is desirable to have a vault with safe in the office, as shown elsewhere in this volume, and in the basement supporting this a storage vault for back records and account books. The vault on the first floor is for the purpose for which such are usually intended, but should have sufficient shelves and cases to admit of the handling of the records, files, etc.

It has been found that in the event of severe fire, with walls of about 18 inches in thickness built up of good hard brick, in which there had been no iron work whatever, results were very satisfac-

tory. It is necessary in building such vaults that they rest upon their own foundations in the basement. It is recommended, however, that an air space be put between the outer and inner walls, as shown in Fig. 59. For reasons already stated, vaults built entirely of concrete would be as good as those of either hollow tile or brick. In no case whatever should such inclosures be built of plastic material, such as has been described.

In building vaults, care should be taken that all of the work be laid in cement mortar, and that this be done in the most careful manner. It is not good practice to put into a building so-called fireproof safes, and depend upon them absolutely for protection, for in a large percentage, which runs well over 65 or 75, it has been found that the contents of these have been totally destroyed in large fires. The statistics on the subject of vaults in fires show that the best protection is afforded by the brick vault, substantially constructed, with iron doors both on the inside and outside edge of the wall, making a vestibule between them. As can readily be

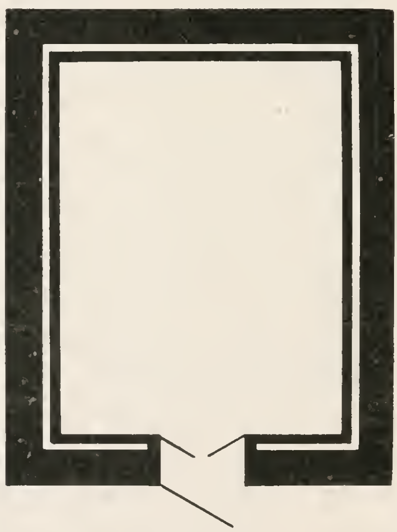


FIG. 59.

imagined, the bolt work on these doors must be of the best, so that when they are closed they are practically air-tight.

SYSTEMS.

CONCRETE.—In the choice of material for fireproofing by the reinforced concrete method, such materials as are at hand must be used, but these should be either crushed stone, slag or washed gravel. In using the latter, care must be taken that the slag is of good quality and that the gravel is thoroughly washed, screened and free from loam. It is stated that when gravel is so treated

that owing to the variation of size a denser and more compact mass can be obtained than by other means.

SAND.—The sand to be used in this form of construction must be free from loam and other foreign matter, and its variation in size such that it will go through from 20 to 80 mesh screens.

STONE.—If broken stone is used, this should vary in size from ¾ inch to 1½ inches, but none should be finer and none coarser. The same sizes will govern crushed slag. If gravel is used, the size of the stones can vary from what is known as torpedo sand to 1½ inches. It is, however, better to screen the gravel, getting the stones to run from ¾ inch to 1½ inches, as for crushed stone, and mix the sand afterward. This is a precaution which it will be well to insist upon, as it is practically impossible to get gravel free from loam and in screening and washing this is eliminated, and then follows the same course as for crushed stone and slag. The matter of using screenings, as the fine particles of crushed stone are called, is not to be recommended, as the greater part of this is usually a powder which will not make as strong mortar as clean, sharp torpedo sand.

CEMENT.—In the choice of cement for the work it is safe only to use the very best Portland. Not too much stress can be laid upon this point, for it is on this material, its proper incorporation into the mass, and the quality of it, which determines the strength of the whole. It is a matter which must be left to the architect, for he is conversant with the grades and quality of the material. There is one means at hand, however, which will be worthy of note in choosing the cement. The government tests on the material and the reputation of the firm making the material will be the best guide in most cases.

CONCRETE.—The proportion of the material in concrete varies, but for ordinary purposes one part of cement, two and one-half parts of torpedo sand, and five parts of crushed stone or gravel will be the standard. For beams and such parts of the work where there are concentrated loads, the proportion would be one, two and four. In mixing the concrete, if it is done by hand, the method given here is probably the best. Machine or "batch" mixtures need not be treated here, as the concrete construction companies doing this work have their "batch" mixers. Of these there are so many that to attempt to describe them would necessitate a special treatise in itself.

By the hand mixing process, which in most instances, at present, is the one used, the sand should be spread two inches thick on a tight floor; the cement is then spread evenly over this. These are then thoroughly mixed until a uniform color is obtained. The

water is then added and the mixing continued until a good, plastic mortar is formed. This mortar is then spread about two inches thick, covered with crushed stone and mixed forward and back until all voids of stone are filled and the face of each stone is thoroughly covered with mortar. The concrete is then put into place and rammed until water appears on the surface. Extreme care must be taken in putting the water into the mixture that it has not sufficient forced to wash out the cement. Slushing water with a pail should not be permitted. All water should be sprinkled on the mass.

Suspended Work.—This is of two kinds—that without the use of steel beams and that which has such structural shapes. The first method is shown in Fig. 60, where the floor runs from wall

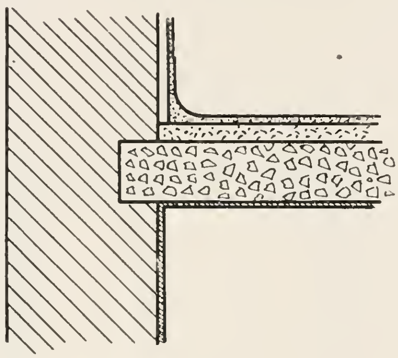


FIG. 60.

to wall, and the second as shown in Fig. 61. Ordinarily in reinforced concrete work all beams are also of the reinforced type. As stated elsewhere, the systems will not be described except as is necessary to illustrate the different methods. The entire design of such a floor, so far as its thickness and general construction is concerned, including the reinforcements, depends solely upon the loads to be sustained. For hospitals the following table (Fig. 62)

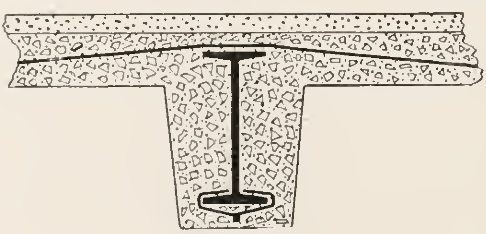


FIG. 61.

will give such loads, which for the purpose of hospital construction are sufficient. In exceptional cases where there are concentrated loads, such as water tanks in pent houses, special and exact calculations will be necessary. All loads given are "live" loads, and

the weight of material used in the construction of floors must be added to these:

Live loads for floors.......... 80 lbs.
*Live loads for ceiling .... 35 lbs.
Live loads for roof .... 50 lbs.
Live loads for stairs .... 80 lbs.

FIG. 62.

BEAMS.—Beams, as mentioned, can be of two kinds—structural shapes or of reinforced concrete. Fig. 61 shows the former and Fig. 81 shows the latter form of construction. The use of structural shapes is usually attended by fireproofing of tile, but, as shown in the figures, this is unnecessary, as it can be done wholly in concrete. Care must be taken, however, to reinforce the lower edges, as shown at "A," as it is here that the protection usually peels off. With a reinforcement as shown this would

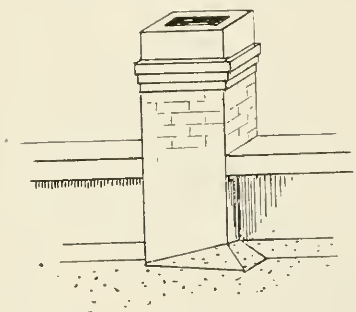


FIG. 63.
Saddle.

practically be impossible. In the flat type floor, where all supports are walls, as in Fig. 1, such beams are only necessary over openings.

CENTERING.—In suspended floors care should be taken that all centerings—i. e., supports for the work during construction—are securely built of surfaced material, straight, smooth, and, above all, level and of such character that the floors are held in shape until the concrete has set. Centerings should be left not less than two weeks, and three weeks would be better. When they are removed this should be carefully done to prevent deflections and marring of the work.

TEST.—All floors should be tested with uniformly distributed loads of not less than twice the live load called for. If they deflect under these loads, when the latter are wholly removed (after

*This does not include such portions as are used for attic floors, which sustain special loads as mentioned.

at least twenty-four hours) the floors should assume their former position without showing deflection under micrometer tests.

IRON.—All iron should be protected from fire by at least one inch of concrete and in beams this should be at least 1½ inches. There should be no rust scales on the iron when put into the building, but a slight film of red rust is not objectionable. No bars in reinforced concrete should be painted, as this prevents the adhesion of the concrete to the iron, the bond being imperfect.

PIPE SLOTS.—All slots for pipes should be formed by sleeves of galvanized iron or wooden blocks, so as to prevent the necessity of breaking such holes through for pipes after the floors are complete. If holes must be put in after the concrete is set, they should be carefully drilled.

ROOF.—The roof should be finished with a coat at least ½ inch thick, as is done on floors, and given the proper slope. The method of covering this will be described in the chapter on roofing (Fig. 66).

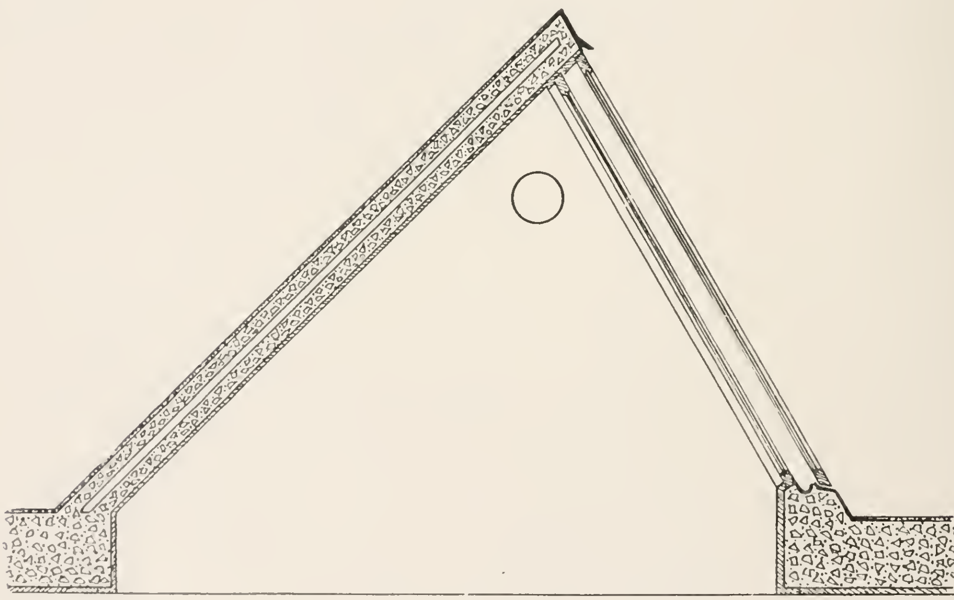


FIG. 64.
Reinforced concrete skylight.

Too often the matter of proper drain of roofs is not seriously considered, this being dismissed with but little thought for the best methods. At all points where the slope is intercepted by vertical obstructions, such as skylights and chimneys, saddles should be built. The filling for these can be of cinders, but the top must have a heavy finishing coat. Fig. 63 shows such a saddle. The skylights above the ceiling line can be built of concrete, that

portion above the roof being of reinforced type. Fig. 64 shows a simple form of such a skylight.

Skylights will be fully treated elsewhere.

STAIRS.—Stairs of reinforced concrete need no special mention.

The illustration (Fig. 65) given here will be sufficient to show how one of the many forms are built. Care should be exercised to have proper lugs built in, to which the guards or railings can be fastened. Some of these stairs are built with stringers of reinforced concrete. The risers and treads of such stairs can be finished in flake mosaic, or the treads can be equipped with patent safety treads. Marble is not recommended for treads, but one of the varieties of slate is very satisfactory.

CEMENT WORK NOT SUSPENDED.

FLOORS.—Before leaving the subject of concrete fireproofing

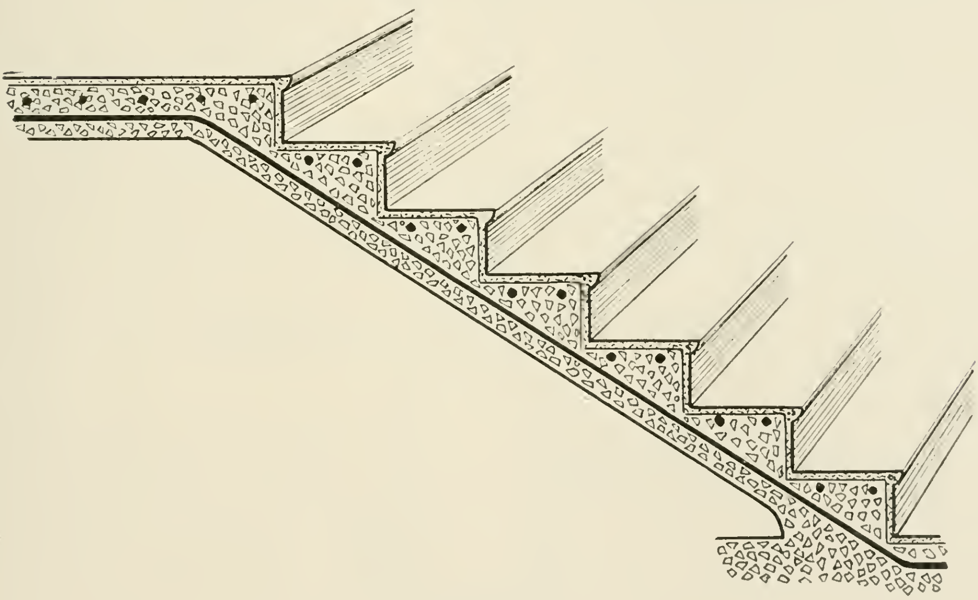


FIG. 65.
Stair of concrete.

the matter of concrete floors for bases, areas, etc., will be mentioned. They do not ordinarily come under the head of fireproofing, but in all such work, of whatever system, there is some concrete used, and the entire concrete work is ordinarily done under one contract. The subject is one with which all architects are familiar and needs no separate chapter. The ground upon which the floors are to be laid should be tamped solidly, and in all cases covered with cinders at least 6 inches thick; these should be also tamped wet to make a firm surface ready for the concrete. Upon this base is laid the concrete at least 3 inches thick. The pro-

portions of this and the manner of putting it down being the same as for suspended work.

Upon this concrete is put the wearing surface, which should be $\frac{3}{4}$ inch thick, made of one part of cement and one part of sand. This should be leveled off with proper slopes to all drains and then trowelled down within two hours. The latter process must be done carefully, as too much working draws the cement to the surface and makes a brittle floor, which cracks and crumbles. The important point, however, in laying the basement floors is that they be made thoroughly water and gas proof. This can be done in several ways, but only two such methods are given here. The first has the decided advantage of being both effective and economical and needs no special care other than is usually employed in mixing concrete. The second applies more directly to localities where there is tide water. A combination of the two methods can also be used. The first method has been described under Masonry in connection with damp-proofing of walls. It consists of mixing about 2 per cent. of specially prepared compounds in powder form with the dry cement and then proceeding as ordinarily described for the work. The second method has also been described under Masonry and, as stated, applies more directly to localities where tide water prevails. The latter method is shown in Fig. 20, which also shows the construction of the floor as mentioned above.

FIG. 66.

After the rough concrete or base is laid over the cinders, the damp-proofing mentioned under Masonry must be laid flat, as shown in Fig. 21, and over this key, as well as over the entire floor, two layers of tarred felt should be laid, with special cements applied as interlay between these, and also on top and bottom as well. Tar products with cement construction are not impervious either to water or gas, and both of these must be most rigidly excluded.

After the floors are dry, preferably just previous to occupancy of the building, they should be filled with a cement filler, and given a heavy coating of cement floor paint. This makes floors so treated impervious to either oil or water, and above all prevents disintegration of the cement and dust produced by friction of shoe soles, which has been a very serious objection heretofore.

Sidewalks.—It is not necessary to dwell at any length upon the subject of sidewalks, but the same care should be exercised in this as in the remainder of the work. Cinders should always

be used as a base. In making driveways, they should be built with crushed granite, about one inch cube instead of using crushed stone. The surface should be one inch thick instead of three-quarters inch, as for other work, and should be deeply corrugated to prevent slipping, with the corrugations made so as to drain.

HOLLOW TILE.

In this form of construction, where the use of structural iron is necessary, there will be no attempt made at calculations of the size of such shapes, as this is purely an engineering problem. Mention is made here, however, of this point, in order to show that no exact data can be given offhand without concise detail as to length of spans, loads and method of applying the tile. The illustrations show these methods without reference to the engineering calculations mentioned (Figs. 67, 68, 69, 89).

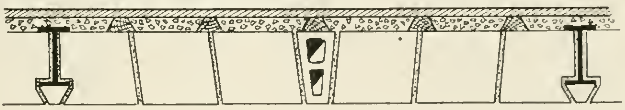


FIG. 67.
Flat arch.

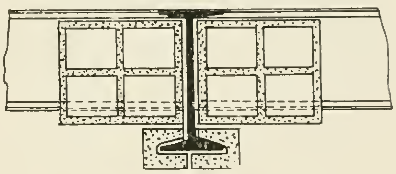


FIG. 68.

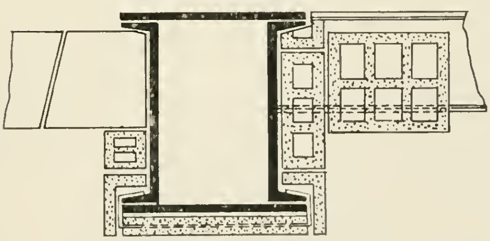


FIG. 69.

After the structural iron is placed in the building it is encased in fire-clay tile, except such portions which in the construction of the building are encased in brick or concrete. The shapes, sizes and different usages to which this fire-clay is put in the construction are fully illustrated.

It is necessary that in placing tile, other iron than the structural iron be used. These consist of T and L irons, shaped as their names imply, which are put into vault tops, lintels over doors in interior partitions, and in ceiling and roof construction, as in Fig. 66.

TILE.—This is a fire-clay material which should be hard burned and free from defects for use in fireproof buildings. From this are built the floors, ceilings, roofs, partitions, furring, backing of walls and the encasing of all steel and iron work and pipes.

The tile is put into floors in arches, either flat or segmental, as shown in Figs. 67 to 71. Partitions are put directly on these

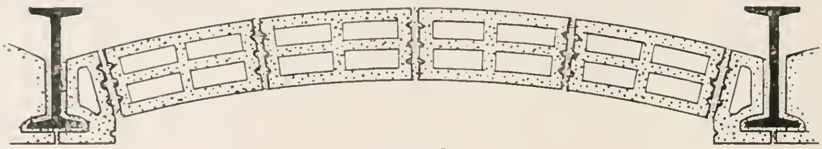


FIG. 70.
Segmental arch.

floor arches, as shown in Figs. 57 and 58, and vary in construction with the type and thickness of tile used. They should be made straight and plumb, as the plastering goes directly on them. The blocks should be scratched before being burned to admit the plaster and make a good bond.

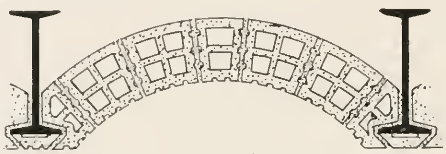


FIG. 71.

COLUMNS.—Columns are usually fireproofed with special tile, in some instances provided with slots to receive pipes where these come at such points, as shown in Figs. 72 and 73. The tile should be set with an air space between fireproofing and metal. Each tile should also be secured in place and to each other by means of keys and to the column by heavy copper wire. Figs. 72 to 78 show

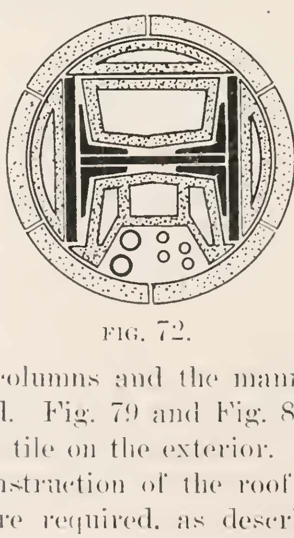


FIG. 72.

types of fireproofed columns and the manner in which they are protected as described. Fig. 79 and Fig. 80 show the reinforced concrete columns with tile on the exterior.

ROOF.—In the construction of the roof the flat arch is used, and where saddles are required, as described under reinforced

concrete, they are "furred up" with cinder concrete and finished with the remainder of the roof. All tile above the roof, or wherever it is exposed to the weather, should be vitrified so as to be waterproof.

SKEW BACKS.—As shown in the illustrations, Fig. 70 and Fig.

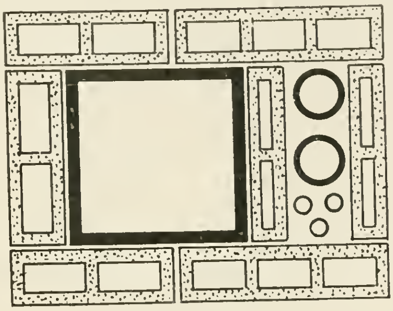


FIG. 73.

71, the skew backs or spring of the arches should be carefully set and rest squarely on the flanges of the beams and make connection with the fireproofing under the beams; such shapes must necessarily be made as will do this in all cases.

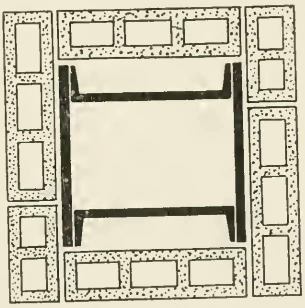


FIG. 74.

The keys of the arches must also fit tightly.

SLOTS.—Slots in column fireproofing should be molded so as

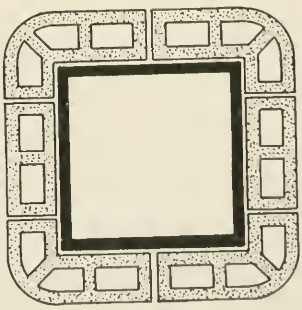


FIG. 75.

to prevent cutting in these tile. Dies are usually made for this purpose and the tile made from these. See Figs. 72 and 73.

SETTING.—It is important that all of the tile work fit closely;

that is, extend close to walls and ceiling and fit closely around all pipes and other openings; that no mortar joints should exceed one-half inch in thickness; that the tile be laid to break alternately in all cases; that all joints be slushed full, except the book tile where joints are smooth and the surface even.

MORTAR.—The mortar for tile fireproofing work should be good lime mortar tempered with cement. This tempering should

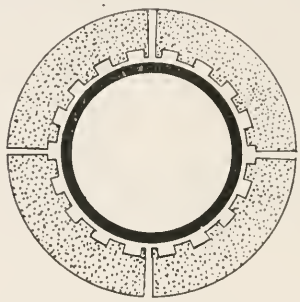


FIG. 76.

be done on the scaffold when the tile is laid and not before, or in quantities as the cement sets quickly.

DEAFENING.—Sound-proofing is done in the manner described in reinforced concrete, and it is well to again call attention to the protection of pipes when cinder concrete is used for this portion

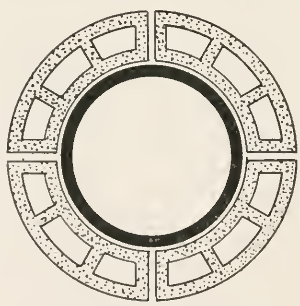


FIG. 77.

of the work. Sleepers are put in for floors where they are of wood, as shown in Fig. 67.

OTHER METHODS.

As shown in Figs. 81, 82, 83, 84, a combination of hollow tile and reinforced concrete is used. There are several methods employed in this class of construction, but a general discussion will fully explain them, as they are all of the same character. The system shown in Fig. 81 has many admirable features. The use of the tile to fireproof the concrete is unique, inasmuch as the former is fireproof. The argument advanced in favor of this form of construction is that in severe fires concrete is liable to disintegration, and that the tile protects the concrete, and even if the former

is badly damaged it can be removed, leaving the strength of the floor unimpaired.

The fire-resisting qualities of concrete have been subjects of much dispute. Theoretically, the above may be true, as concrete,

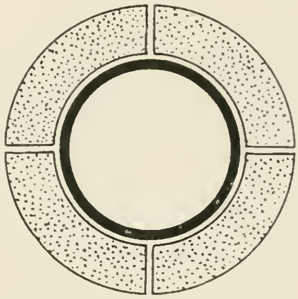


FIG. 78.

being a hydrated compound, should disintegrate with the evaporation of the water of this hydration by the heat. Practically such is not the case, for it would require extremely high temperature to draw off the water of hydration, inasmuch as concrete is a

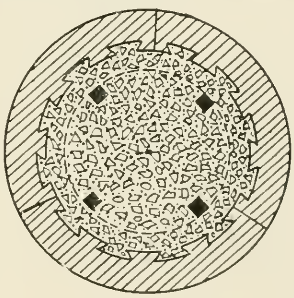


FIG. 79.

poor conductor. In actual tests by experts and municipalities, and in many conflagrations, the theory has been absolutely controverted, for concrete has withstood the severest test in all of these cases.

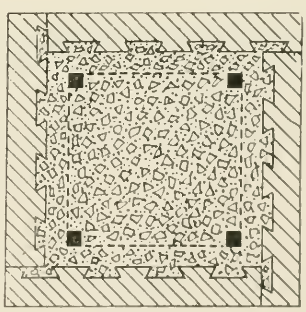


FIG. 80.

However, as the tile is not meant to add strength, but merely to protect the structural parts, it is mentioned here as a method. In Figs. 79 and 80 columns of this construction are shown. So

far as cost of construction is concerned, there can be no material difference between this form and the simple reinforced concrete. The tile being beneath the concrete would necessitate much simpler and less expensive centerings, but the additional cost of tile would offset this.

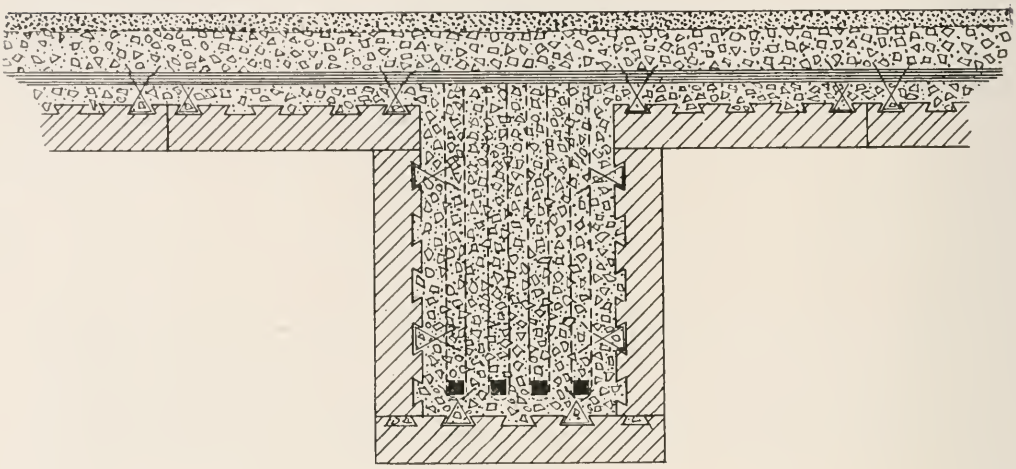


FIG. 81.

In Fig. 85 is shown a form of construction which is admirable and is especially mentioned here, since it embodies the first principles of the joist construction. It is extremely simple and rapid

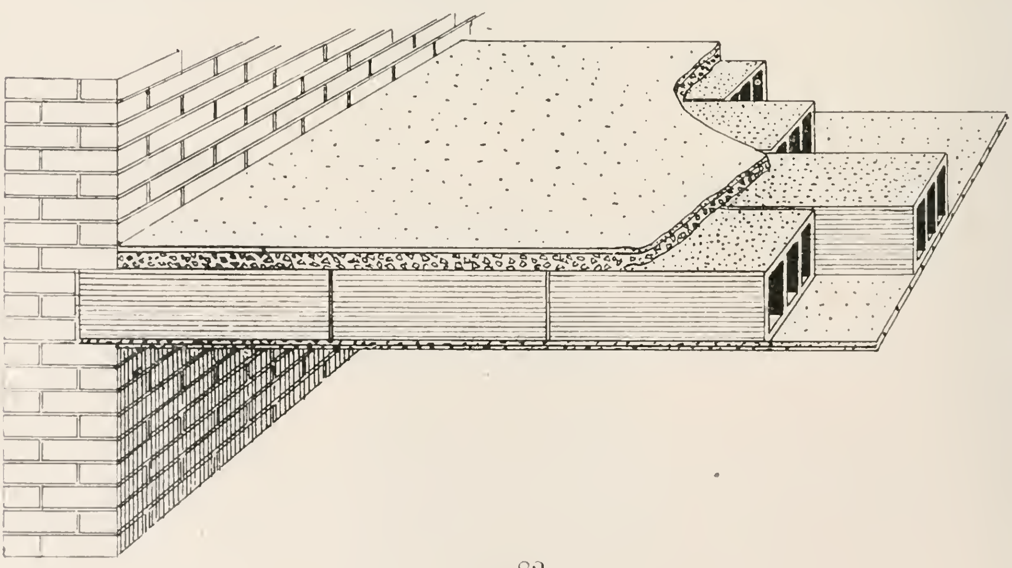


FIG. 82.

in its application and is doubtless one of the best forms that can be used for fireproof floor construction. It provides a flat arch with that portion which does not directly contribute to the strength, except in compression in a lateral direction, of material

which makes floors from 30 to 40 per cent lighter than systems of all reinforced concrete and still retains all of the advantages of the latter as to strength and economy.

The reinforcement is placed in the concrete joists, as shown, with a lateral reinforcement over the top.

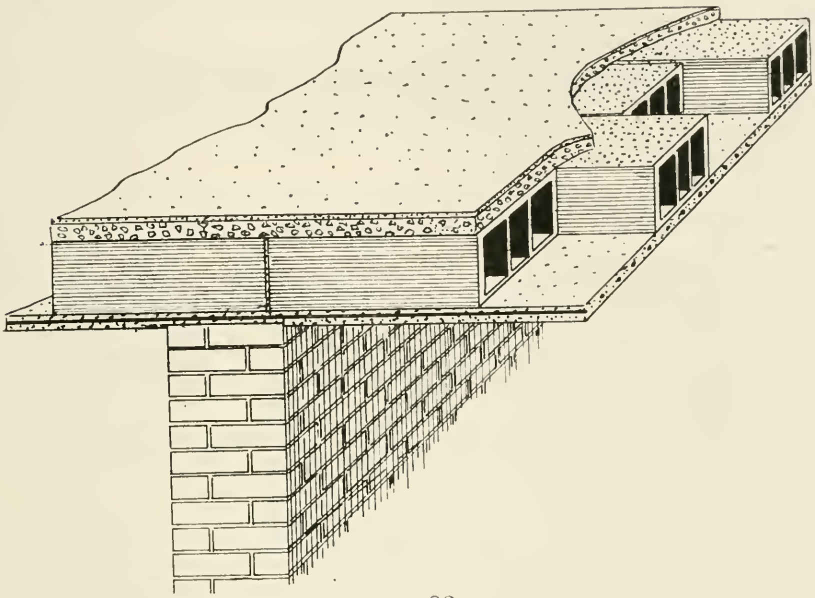


FIG. 83.

The system illustrated in Figs. 82, 83, 84 is for long span. flat construction. The three illustrations show the construction to an end wall, a bearing wall and over structural shape, and are the same in this regard as the all-concrete floor. It is the reinforced

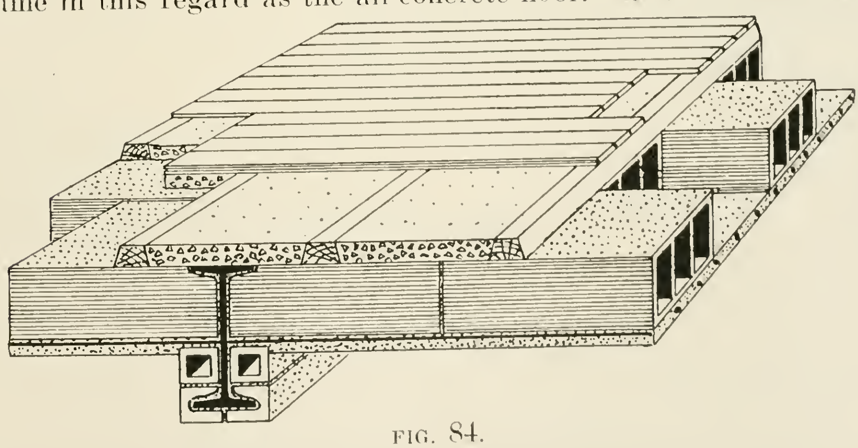


FIG. 84.

pattern and can be erected wholly without structural iron. It is from 30 to 40 per cent lighter than the reinforced concrete for the same strength, and has the advantage of being practically sound-proof. This system is formed of large steel wires transversely interwoven, with still larger wires placed 4 inches apart. These

last run from bearing to bearing in unbroken lengths along the line of natural tension.

SKYLIGHTS.—What has been said under concrete regarding skylights refers also to these in all tile construction, or in a combination of these methods. Fig. 88 shows a skylight built of tile on a reinforced concrete roof.

FIG. 85.

STAIRS.—Stairs of concrete have been fully described and illustrated. Those of other fireproof material can be built in several ways. In Fig. 86 is shown such a stairway, built entirely of hollow tile. The risers and treads of these can be finished with marble, some variety of slate or in plastic material like cement with safety treads set into the material, or they can be built of terra cotta tile completely.

Fireproof stairs are built as shown in Fig. 87, entirely of iron,

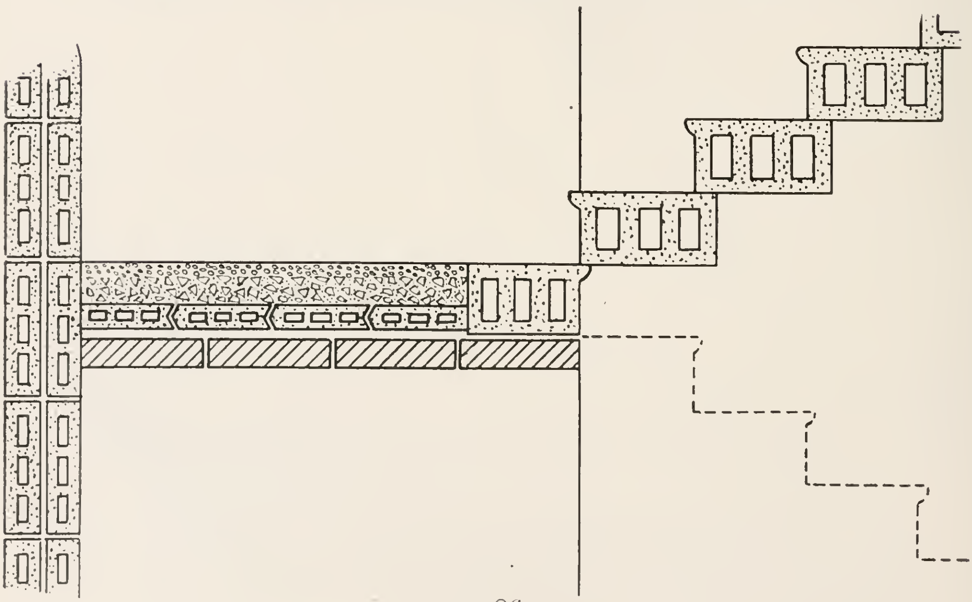


FIG. 86.

the stringers, risers and treads being of this material. The treads on these are often made of marble or stone.

Handrails for stairs should be placed on both sides. The pattern of these depends wholly upon the general design of the entire work. If stairs are built around the elevator shaft in their own brick or tile enclosures a simple handrail securely fastened to the wall, or brackets on one side and fastened in the same manner to the iron enclosure of the shaft on the other, is sufficient. These

are matters of detail, however, with which all architects are familiar.

Under this heading also must be placed the metal-clad trim, doors and other interior wood work mentioned in the chapter on Carpenter Work. Figs. 38, 41, 52, 53, 54 show this form of fire-resisting woodwork.

The all-metal form for the interior trim of buildings is admirable in many ways, but its disadvantages lie in the fact that it

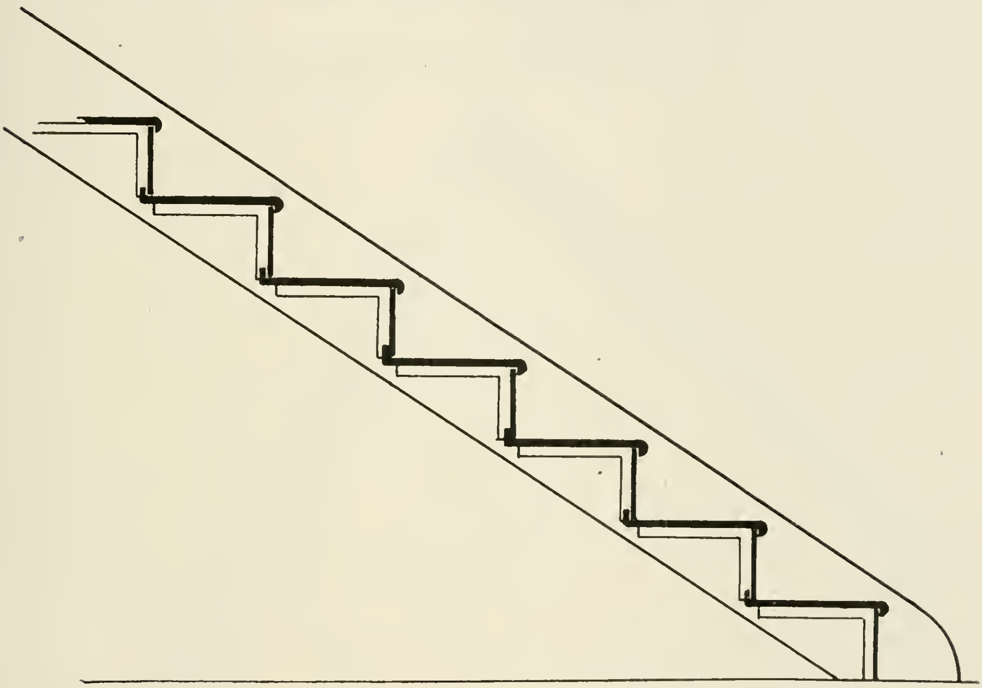


FIG. 87.

is both expensive and heavy. It is made of bronze or other heavy metal, so as to prevent denting. As will be evident, doors of these materials, while they would have the fireproof qualities, would be too cumbersome for ordinary purposes.

Fireproof Windows.—Little need be said regarding fireproof windows, as these were fully explained in the chapter on Carpentry (Figs. 50 and 51). Mention is made, however, of the all-metal form of frame and sash. These have many advantages besides their fireproof qualifications, their durability and the fact that they are not subject to change in form or shape due to weather conditions. Expansion and contraction of the metal is amply provided for in the better forms of these, so that they are at all times easily operated.

Wire Glass.—Wire glass as a fire retardent is too well recognized to need special attention. This material comes in many forms—the translucent maze and chipped glass, rough wire glass

for skylights and the polished plate wire glass for interior partitions. This glass has the added advantage of being less liable to breakage than the ordinary plate or window glass, the wire acting as a reinforcement. In doors where glass is used this would be of great value.

Fireproof Paints.—The subject of fireproof paints is one which, in hospitals, need not be seriously considered, except in instances where it is desirable to use them, as, for example, in painting shelving in store rooms.

Lockers.—Lockers have been fully treated in another chapter,

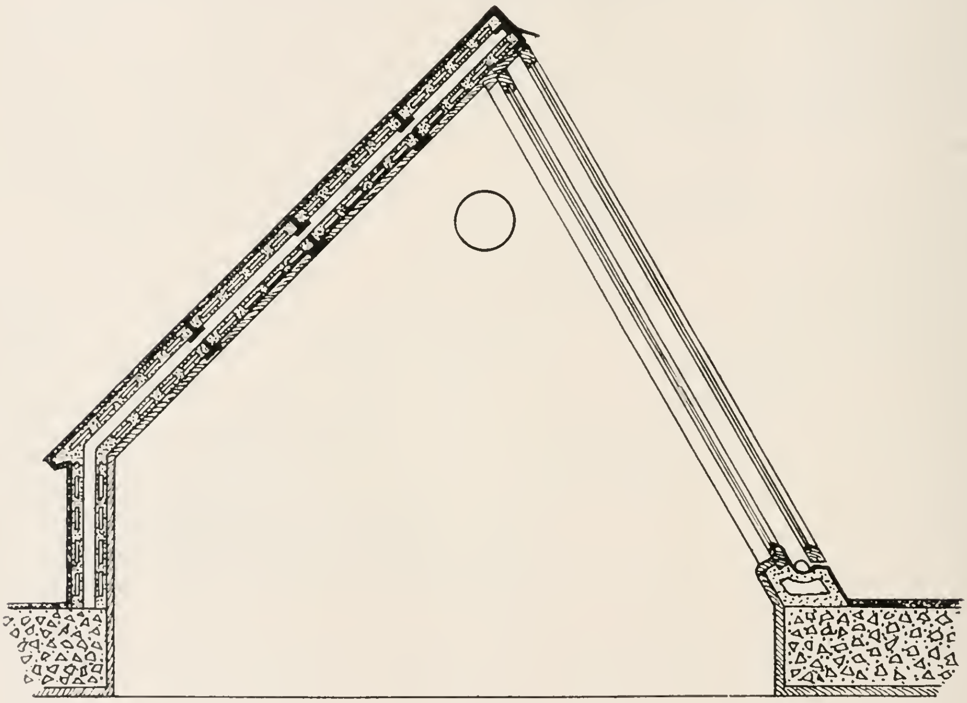


FIG. 88.

but attention is again directed to the fact that these should be absolutely fireproof. Figs. 55 and 56 show such lockers.

FIREPROOF WOOD.

Fireproof wood, as its name implies, is wood treated in such a manner that it will not burn. It is fire resisting, or slow burning, rather than fireproof. There are several processes by which this effect is produced, all of which are patented, and all of which are widely different in character. In general, the method consists of impregnating the wood fiber with certain chemicals. The wood must be kiln dried for several weeks after this impregnating, so that the wood is "bone dry." The treatment in no way affects the color of the wood, except to make it somewhat richer in

tone, and in no way impairs its strength or its working quality. The industry is evidently in its infancy. The government uses

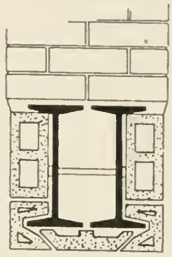


FIG. 89.

this wood in battleships which would indicate that it has merits.

Fireproof floors of wood, with an air space under them, make excellent fire retardents.

CHAPTER XIV.

PLUMBING.

Plumbing to the majority of people simply means the installation of certain fixtures in given spaces, arranged conveniently for various purposes. This primarily may be the case, but the objects to be attained by plumbing, and the means of obtaining them, are much more complicated and of vastly more importance. Strictly speaking the fixtures are secondary, and the demand for their being placed conveniently has given rise to the essentials of sanitary plumbing.

Dr. Azel Ames says: "It goes without saying that primarily the object of plumbing laws in states, and of ordinances of like character in municipalities, is to secure for the public safety from unhealthy influences known to reside in sewage and its gases. It is, however, a fact well known to those familiar with these laws and their genesis, and with the advanced knowledge of recent years in sanitary science, including physics, bacteriology and pathology, that there is scarcely a state or a community in which the so-called sanitary laws, and more especially the laws and ordinances relating to plumbing and sanitary construction, fit the facts or accomplish what they are ostensibly designed to do.

As a matter of fact, in a very large percentage of cases they defeat their primary object, and are positively unsanitary in their results, while their enforcement by authority is an outrage upon the citizen, a travesty upon present sanitary knowledge. This is due, as has been suggested, in no small number of cases to the fact that most of the now existing sanitary laws and ordinances were framed and adopted by those having but little sanitary knowledge, and since the time of their adoption have not been changed, amended and improved to keep pace with the rapid and positive advances in sanitation. The existing requirements of construction have been copied generally from one city and town by the other, with the result that the above named condition is very general."

It will be seen from this that it is not safe or expedient to rely upon state or municipal laws for the essentials of good plumbing. This is particularly true of plumbing in hospitals, where it is imperative to have only the best and most modern. It

is not the object of the authors, nor within the province of such a volume as this, to go into the *minute* details necessary to obtain the best results. The architect's specification should fully cover all of these points, and his knowledge of sanitary science should be sufficient to see that they are carried out. Plumbing, however, is not limited to sanitation, although its object is to attain this end and eventually revolves about this pivotal point.

It is only within recent years that bath and toilet rooms have been made commodious, with proper lighting and ventilation. The old method of inclosing all fixtures, such as lavatories, sinks, tubs and closets, with wood, and putting them in the darkest and poorest ventilated spaces has been entirely superseded by the modern bathroom and toilet room, with an abundance of sunlight and ventilation. Moreover, the fixtures themselves are now set free from walls and are so made that every part of them is exposed and can be kept clean. Instead of the old iron closet with its wooden seat and surrounding box, we have the closet made of vitreous ware. Sinks, lavatories and hoppers are now made of enameled iron and vitreous ware or porcelain ware, which are absolutely non-absorbent.

Drainage systems are not the result of guesswork, but are now proportioned in size by exact computation of requirements. Ventilation of these systems is calculated as exactly as it is for rooms. Supply pipes for water are not installed in the haphazard fashion of former years, but each pipe is designed for the amount of water it is to supply. Water supply itself has undergone pronounced changes, as only the purest water is now used, and if not directly obtainable, systems of filtration are installed and sterilization and distillation plants are put in.

Piping has undergone a radical change also. Instead of light piping of lead and iron, we now have heavy lead pipe, brass pipe, white metal piping and galvanized seamless iron tubing and pipe. The connections and fittings for these have been designed with a view of decreasing friction, of making any desired change in direction gradual.

All of these have directly contributed to the general improvement so that now a modern system of plumbing and its installation has become an exact scientific reality.

The general conditions necessary for the installation of such a system are not in the least complicated, as will be seen. The special requirements of such systems are, however, a serious problem for the architect and sanitary engineer. A water supply system in a hospital may be simple and still be of such nature as to make its installation the most difficult.

System and installation are often widely divergent. At first glance the supplying of fixtures may appear without the least semblance of intricate calculation, but the running of supplies for hot and cold water, both filtered and distilled, with all of the attendant apparatus, and the great distances between fixtures in different parts of the hospital, are serious considerations.

The primary requirements, however, in all hospitals are sufficient water at all times for all purposes; fixtures of the open type, either in enameled ware, porcelain or vitreous ware; waste pipes calculated as to size so that they will be self-cleaning, but not so small as to not fulfill all requirements; ventilation of rooms, fixtures and the system; good joints in good quality pipes, and pipes that will not corrode; a system that is water-tight, gas-tight, and which is so installed that it will drain perfectly at all times, and one which is securely installed; one which will work perfectly so that there will be no interference of one portion with another; which is noiseless in operation and which is accessible in all its parts throughout.

DRAINAGE SYSTEMS.

The drainage systems in hospitals include the house sewer, house drain, soil, waste and vent stacks, branch fixture connections and fixtures and the subsoil drainage. The house system is that portion of the system which connects the house drain with the street sewer, or to such other means as is provided for the proper disposal of sewage.

TILE SEWERS.—While tile pipe is not the best for the house sewer, it is sometimes necessary to use this, owing to local restrictions, and also to the fact that the distance from the building to the main sewer or other point of sewage disposal is so great as to preclude the possibility of using iron pipe.

When tile pipe is used it should be of the salt glazed variety with a perfect surface. The hub end and the spigot end must be unglazed to permit the cement to adhere to make a perfect joint.

The laying of tile pipe can be done in several ways. In all of these methods a trench is dug, which is properly graded, so that when the sewer is laid it permits an easy flow of the contents of the sewer to the point of discharge. The tile is laid on the bottom of this trench and blocked to make an even slope. The joints are cemented and these should then be protected by filling in over them carefully before the trench is closed, so as to prevent breaking of the joints. The earth under each hub should be removed when the pipe is laid, thus giving a bearing for the full length of the pipe, which is better than blocking. The method of making a

concrete foundation for the sewer is scientifically the best, but the cost of doing this often exceeds the cost of making the entire sewer in iron, and is therefore not advocated when tile sewers are used.

In laying tile sewer it is imperative that any imperfections, such as warps or bends, should be laid on the side, so as to form no pockets. Tile sewers are sometimes laid on a plank foundation. In this method, the spigot ends must be blocked into the hubs. This is a good method where it is necessary to lay the pipe quickly. If unglazed hubs and spigots are not obtainable, the joints should be calked with oakum and filled with either cement or asphalt, preferably the latter.

Tile sewers should never be used where they cannot be laid below the frost line, or when they run near a well or other source of water supply.

Tile sewers in general are not recommended, as the joints cannot be made tight, and also because they are subject to injury in many ways. House drains in hospitals should never be of tile for the reason given.

Iron Sewers.—Iron sewers possess none of the disadvantages of tile sewers. They are not subject to breakage at the joints nor in the pipe as are tile, and inasmuch as all joints are both water and gas tight, they can be run in proximity to water supply without deleterious effects. Frost will not injure them as readily as tile sewer, and settlement in the pipe will not break the joints; the inner surfaces at joints are not subject to obstructions. Iron sewers are made standard and extra heavy, but the former should not be used, owing to the danger of breakage in calking joints or in settlement of the building.

All iron pipe should be tarred with coal pitch or asphalt, both outside and inside. All joints in cast iron pipe should be lead calked. The calking should be done with a ring of oakum driven well into the hub, and over this should be poured the lead, which must be done in one run, so as to form a continuous ring around the joint. This lead when it has set should be thoroughly driven down with a calking chisel and hammer, so as to expand against the side of the hub and spigot to form gas and water tight joints.

Connections between the house sewer and street sewer, except where the streets are of concrete or brick, or the connection of considerable size, should always be made at an angle of not less than forty-five degrees and should be above the water line of the street sewer. This connection should be made with cement or preferably with connections made to connect iron and tile pipe. Where the house sewer connects with the house drain, when these

is danger of tide water or back water in the main sewer, there should be placed a tide water or back water valve.

HOUSE DRAIN.—The house drain is all of that portion of the sewerage system not included in the house sewer which is horizontally placed in the basement or below the basement floor. All pipe for this portion of the system should invariably be heavy cast iron, coated inside and outside as described, with all joints hermetically sealed with oakum and lead as stated above. Wrought iron pipes are sometimes used where they are suspended above the floor, but they are not recommended, as they rust out and deteriorate rapidly.

The connection between the soil stacks and house drain should be made with fittings which give an angle of forty-five degrees, but this can be varied by the use of differently angled fittings. Such connections should never be made, however, at a greater angle than forty-five degrees, and "T" fittings should never be used,

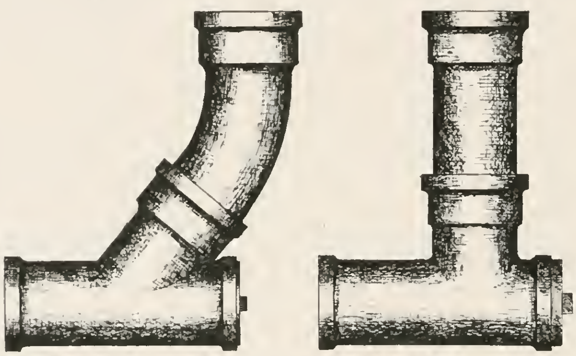


FIG. 90.
"T" fitting.

because the sewage tends to collect at the base of the stack. Fig. 90 shows the proper methods of making connections, and also the "T" connection which should not be used. At the base of all soil pipes, drains, wastes, and at the end of the house drain, there should be placed a cleanout fitting closed with a brass trap screw ferrule with brass plugs, as shown in Fig. 91. If more than one stack enters a run of house drain, the connection should be made in such a manner that the second stack does not enter directly into the house drain, but at one side, and this branch should have a cleanout at the foot of the stack as described (Fig. 91).

There should never be sharp turns in the house drain. All such bends should be at an angle of at least forty-five degrees, or with a large radius, quarter-bend. If the house drain is suspended, it should be put into hangers not over ten feet apart, so arranged as to allow for expansion and contraction of the pipes.

MAIN DRAIN TRAP.—Every house drain should be provided with a main drain trap. This should be put in perfectly level and provided with two cleanout hubs into which are calked two cleanout ferrules. This trap should be located just inside the foundation wall, and the only fitting intervening between it and the house sewer should be a cleanout fitting. This trap is placed

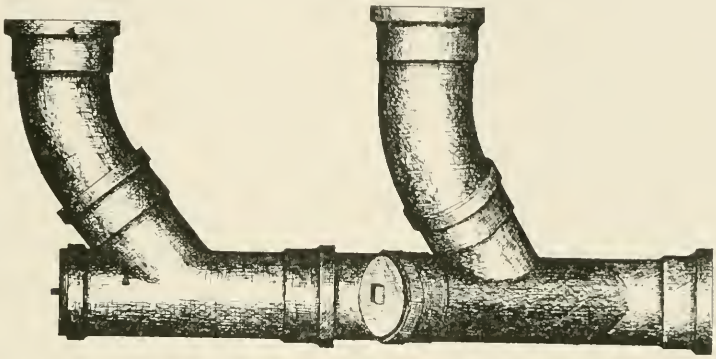


FIG. 91.

in the system to prevent any possibility of gas from the main sewer system entering the building. The double trap here described is the only pattern which should ever be used (Fig. 92).

FLOOR DRAINS.—These comprise all drains used for conveying water from the surface of floors, whether these are in cellar,

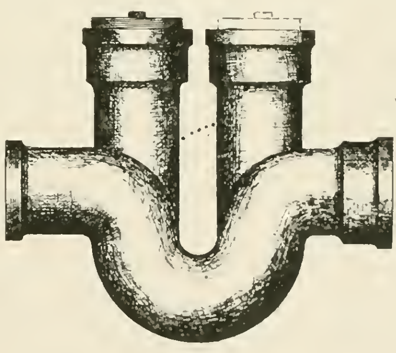


FIG. 92.

basement, or in rooms above the basement. Floor drains should never be used in the basements or cellars of hospitals, if it can possibly be avoided.

VELOCITY OF FLOW IN DRAINS.—There are certain rules which should be followed in the laying of drains to insure proper velocity to the sewage. Drains should be laid so that "for each foot of fall in the drain, allow a length of ten feet of pipe for each inch in the diameter of the pipe." This rule will give to all pipes such a slope that the velocity of the sewage is about 270 feet per minute, which is necessary for perfect drainage. With a velocity

under 180 feet per minute, the water flow is not sufficient to carry away the solids, and with greater than 360 feet per minute, the water will run away from the solids.

The house drain should never be so small that it will not readily carry away all the discharge into it; nor should it be so large that it will not be self-cleaning. House drains must, however, be larger than the largest discharge into them, and in hospitals should usually provide for a maximum removal of 200 gallons per capita daily. The size of pipe should be "one square inch in sectional area of the drain for each fifteen gallons of sewage to be removed per minute."

Fresh Air Inlet.—Provision should be made for a fresh air inlet connected to the house drain to equalize the pressure in the system, and to provide fresh air circulation in the drain stacks. Rainleaders should be trapped directly into the house drain, or should be run to a catch basin which empties into the house sewer.

Yard and area drains should be constructed of cast iron with the grating surface double the size of the drain pipe which runs from the catch basin. Such drains should be connected with the main catch basin or the house drain.

Catch Basin.—Kitchen or other greasy wastes should be intercepted by a catch basin or grease trap and thence conducted to the house drain. Catch basins for receiving wastes should be constructed either of brick, concrete or cast iron. If of brick or concrete, they should be at least thirty inches internal diameter at the base and taper to not less than twenty-two inches internal diameter at the top, and be finished with a stone or iron cover at grade level. The bottom should be at least two feet below the invert of the outlet to the sewer. The outlet should be trapped to a depth of six inches below the invert of the outlet to the sewer, to prevent the escape of grease, by a hood or trap of brick and cement mortar, a hood of concrete or one of cast iron. The invert of the inlet to the catch basin for kitchen wastes should be not less than two and a half feet above the finished bottom of the catch basin.

Stacks and Branches.—Stacks are designated as soil and waste stacks. Branches to these are designated as soil and waste pipe. Soil stacks and soil pipes are used for the discharge from closets, urinals, slop hoppers, and sometimes other bathroom fixtures. Waste stacks and pipes receive the discharge from all other fixtures, including slop sinks.

Soil and wastes can be run in one of two methods—one-pipe and two-pipe systems. Fig. 94 illustrates a two-pipe system with the lavatories and tubs wasting into the soil stack. In this system a main soil stack is used, into which the discharge from

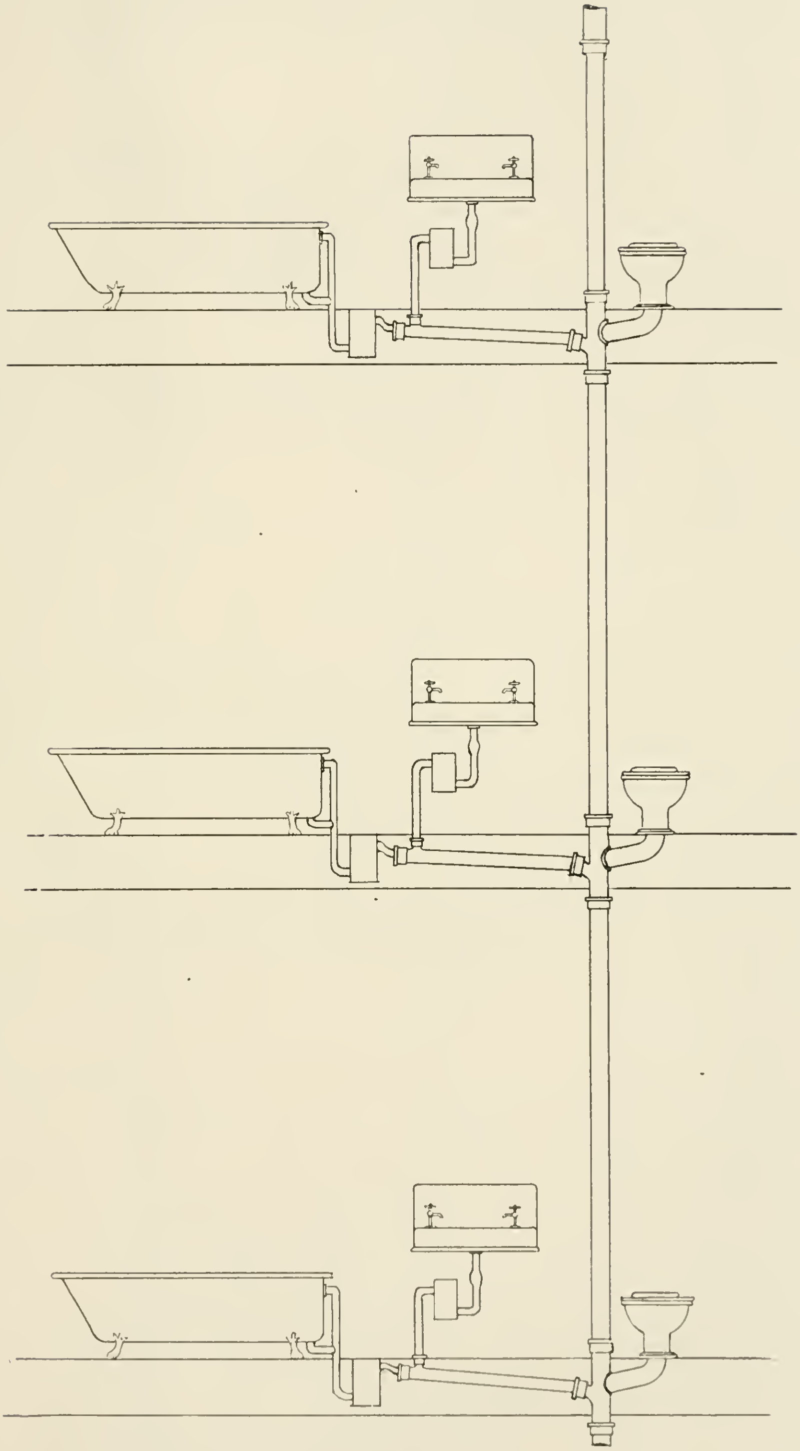


FIG. 93.
One pipe soil system.

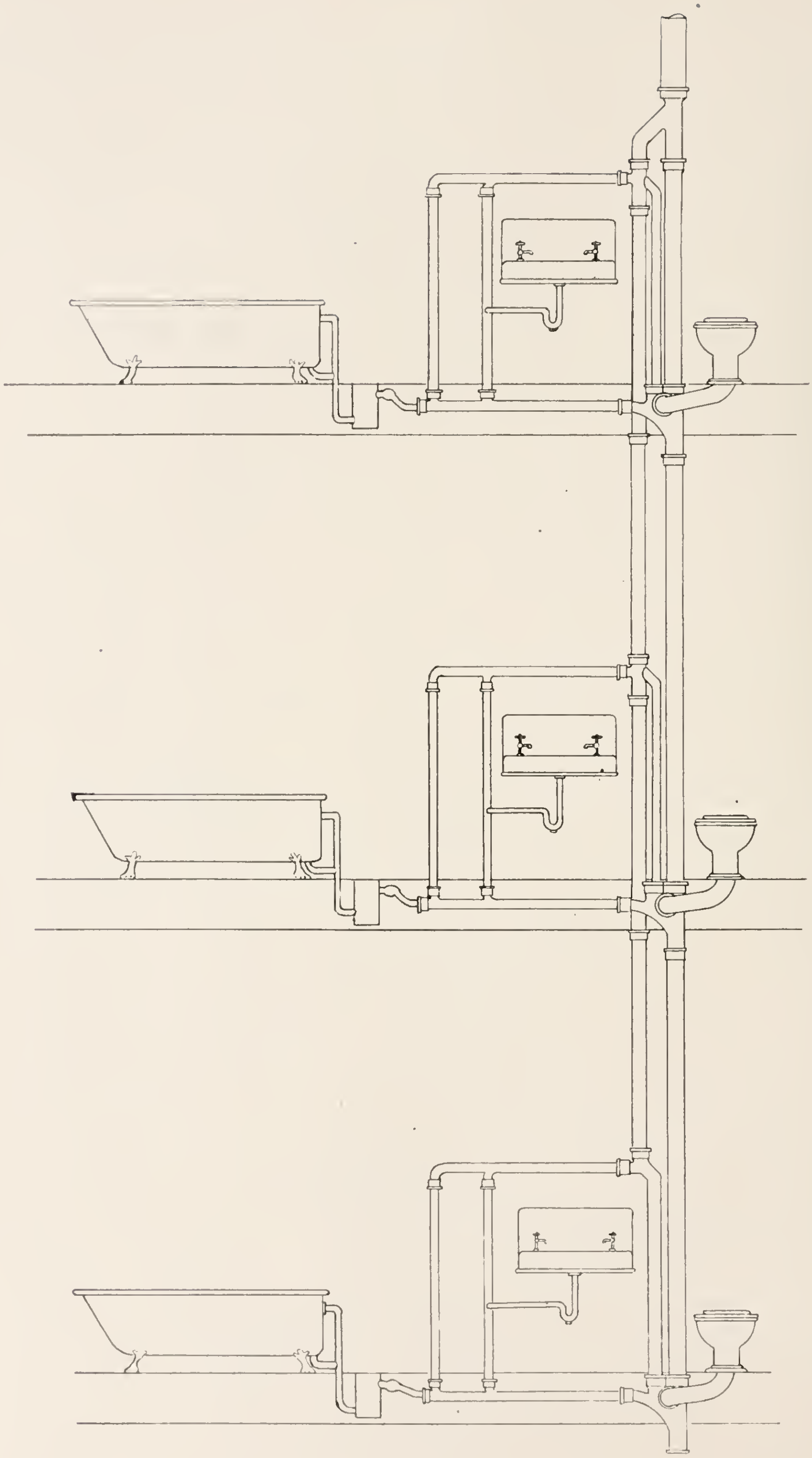


FIG. 94.

closets is through a soil pipe, and the discharge from the other fixtures is through waste pipes into the soil stack. As will be noted,

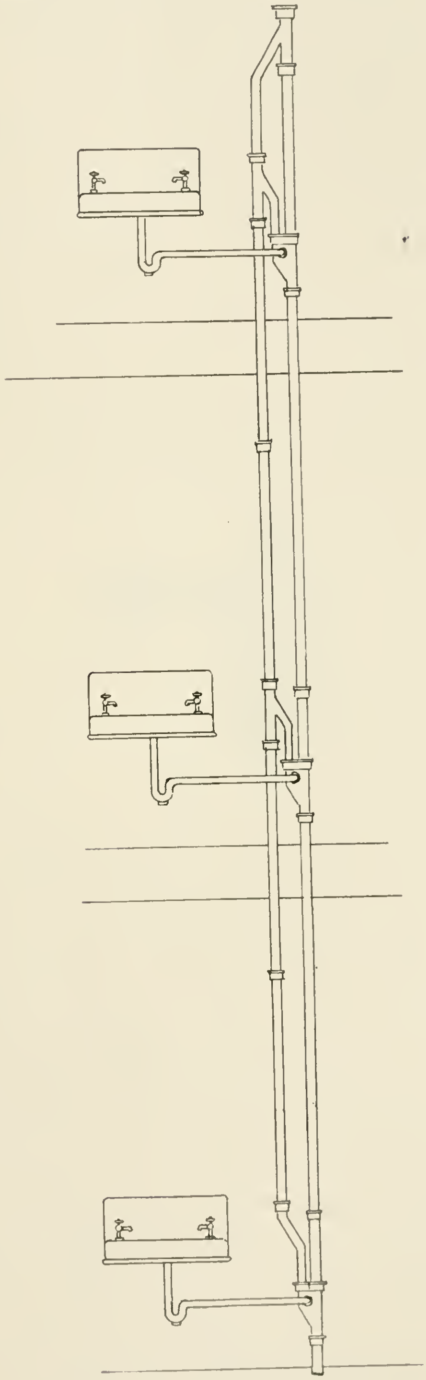


FIG. 95.

there is a vent stack, which branches from the soil stack below the lowest point of discharge of the lowest fixture, and runs above the

highest fixture connecting into the soil stack, or going directly through the roof. In Fig. 95 is shown the method of venting waste stacks. This system is installed as shown with a vent from the crown of each trap to prevent the breaking of the water seal in traps by siphonage and back pressure.

The one-pipe system eliminates the vent stacks, except that the soil stack must be run through the roof, in the same manner as it must in any system. In the one-pipe system, as shown in Fig. 93, the fixtures are equipped with non-siphon traps, as shown in Fig. 96. In this the water has a motion which makes it self-cleaning, as all such traps should be. This system reduces the cost of installation by one-half, and from a sanitary standpoint is equal, if not superior, to the two-pipe system. It is not as absolutely noiseless as the two-pipe system, but the slight gurgling noise is not objectionable, as the pipes are run in a pipe slot away from the habitable part of the hospital. Furthermore, it has the

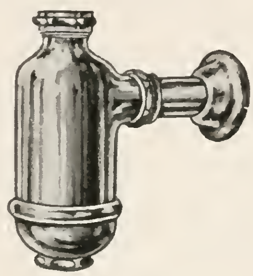


FIG. 96.

decided advantage of making pipe slots possible, whereas in the two-pipe system this is somewhat difficult, owing to the long horizontal runs necessary to get to such a slot. Water closets on a one-pipe system should be back-vented below the floors, as shown, as these fixtures are not made with non-siphon traps.

Grease Traps.—A grease trap is used to intercept the grease from kitchen sinks. One should be installed at every kitchen sink in the hospital, or at any sink into which greasy substances are poured. Such traps should be placed as close to the sink as possible. These traps should be built of enameled iron and so constructed that cold water will circulate around the trap in an outer jacket. This can be done by connecting a cold water supply to the jacket, and running it from this to a fixture, so that the drawing of water at the latter will cause a circulation of the water in the jacket.

Grease traps should be made commodious, their size depending upon the amount of water which is emptied into the sink at one time.

Blow-Off Tanks.—These are installed for boilers in which

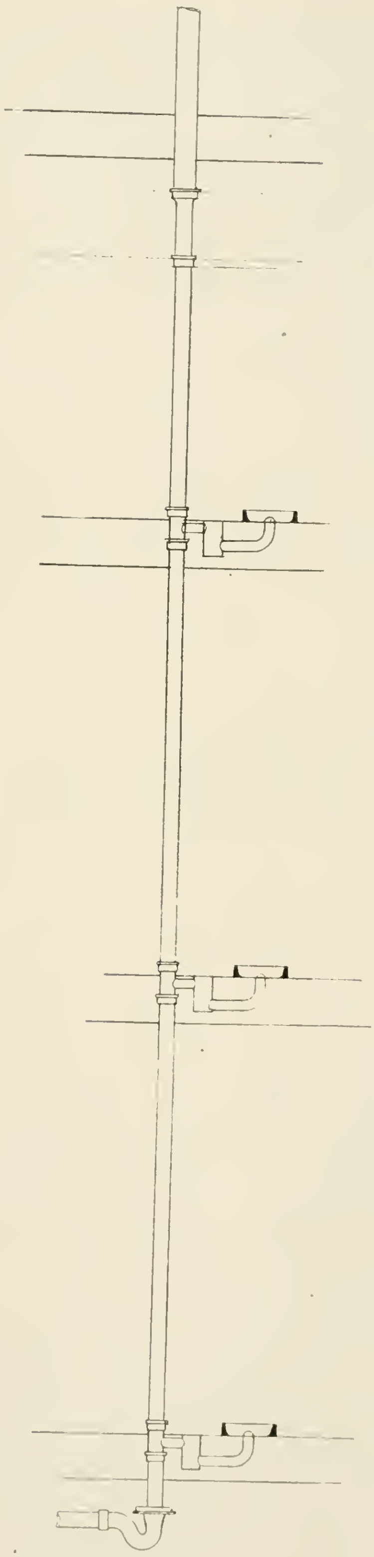


FIG. 97.

there is high pressure steam. Most municipalities make stringent regulations prohibiting steam, exhaust, blow-off, drip and return pipes from entering any sewer, house drain, soil or waste stack or rain leader before the steam, etc., is discharged into a suitable cast iron catch-basin or condenser, from which a special vent pipe not less than two inches in diameter extends through the roof of the building. These tanks must be properly proportioned for the apparatus to which they are connected. Outlets from these tanks should be made larger than the inlet, so as to permit the water from them to enter the sewer at slow velocity, and to permit the replacing of the hot water by cold water.

Refrigerator Wastes.—In hospitals where there are superposed diet kitchens with small refrigerators, provision for wasting these is made as shown in Fig. 97. The connection at each floor should be made through an "S" pattern siphon trap, or preferably a drum trap which is accessible and easily cleaned.

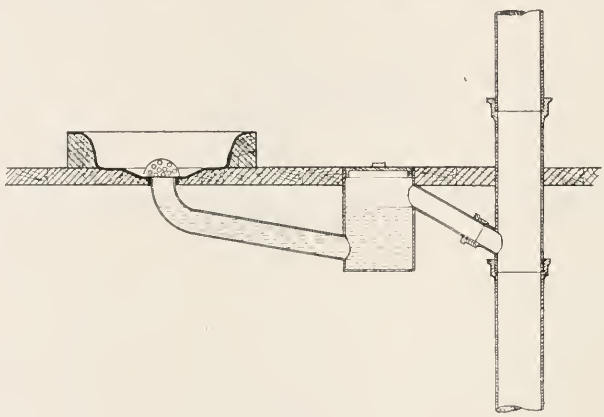


FIG. 98.

The fittings in such a system and the connections to the safes must be such that the piping is smooth on the inside. This may be done by reaming the ends of the pipe and screwing them into recessed drainage fittings.

All pipe should be galvanized iron not less than two inches in diameter and should never drain directly into a sewer, but into a sink that is properly trapped, or into a combination floor drain which has a flushing rim, and hot and cold water supply to it, which allows of thoroughly cleansing the trap. The pipe should extend through the roof. The refrigerator safes can be made in the form of a lead box, formed on bevel strips, as shown in Fig. 98, or can be of cast iron, galvanized type with a hinged cup. The latter can be set flush or on the floor.

Mechanical Discharge Systems.—Mechanical discharge for sewage depends wholly upon the location of the building with

reference to the street sewer, and the requirements of the hospital. These systems are used only when the house drain is below the line of the street sewer.

Subsoil Drainage.—Where there is a condition of dampness or a water level, which would keep the foundations and probably the basement floor damp, subsoil drainage is put in. As stated, however, in another chapter, all walls and basement floors subject to such conditions, as also soil gas, should be thoroughly waterproofed, which would preclude any possibility of dampness in walls and floors. It is, however, well to drain the water, where it is excessive, by means of subsoil sewers placed about the entire building in such manner that the water which flows into them may be readily carried off. These subsoil pipes must be laid over broken stone or coarse cinders, and over them again a bed from eighteen inches to two feet of broken stone should be placed in the entire trench, in order to facilitate the flow of water to the drain tile. These drains connect to catch basins properly trapped, or to the invert or lower portion of the main street sewer.

Testing Drainage Systems.—All drainage systems must be tested thoroughly at least twice before they are put into service. The first is known as the roughing test; the second as the final test, the former being applied when the drainage system is complete except the setting of the fixtures, and the latter when the entire system is complete.

There are two methods of testing by the roughing test—i. e., by water and by air. In the water test all openings are tightly closed, except those above the roof, and the system filled with water until it stands level with the top of the pipes above the roof. The openings in lead pipes should be closed with lead disks soldered on when the pipes are installed, and left until the fixtures are set. The openings in cast iron pipes should be closed with mechanical plugs—no driven plugs should ever be used. The trap openings should only be closed by special trap fittings, as cementing and leading are extremely bad practice, owing to the fact that cement cannot be thoroughly cleaned out, and lead requires cutting away, which can only be done by inserting the hand with the cutting tool into the trap, making it impossible to get a clean job. In the water test the system should be filled slowly from the bottom. All leaking hubs should be calked tight, and in case of split pipe it should be removed and a new section put in and the entire system, or that portion in which defects occurred, retested. Test by water should be done as soon as the work is installed.

The air test is carried out much in the same manner as the water test. All openings are closed, except one into which is

placed an air compressor and an air gauge. The air is pumped into the system and the gauge should register no drop unless there are defects through which air is escaping. This method is not recommended on account of the great difficulty in locating leaks.

Final Tests.—These tests are applied after the system is practically complete, the fixtures all being set. There are two methods of procedure—by smoke and by peppermint. The latter is done by pouring from two to four ounces of *oil of peppermint* into each stack, followed by a quantity of boiling water run into the stack, plugging up the latter after the water is poured, and detecting leaks by the sense of smell. This is not as reliable a method as the smoke test, as there is no pressure employed, and small leaks will therefore not readily be disclosed on this account.

The Smoke Test.—The smoke test is applied by forcing some heavy, pungent smoke into the system under pressure. This pressure must not be enough to force the water seal in traps, but sufficient to force the smoke into all pipes. A one-inch column to balance the pressure will indicate the force of the latter. This method will quickly disclose the smallest leak. The smoke is produced in a smoke machine made for the purpose of smoke tests.

There should be no concealing of sewerage pipes in any manner until the final tests have been made, as it is absolutely necessary that the entire length and all joints of pipes of the whole system be accessible until every part is tested and secured.

WATER SUPPLY.

Installation.—The installation of a water supply in hospitals should not be a matter precedent, but should be the result of exact calculation as to the size of pipes, their location and installation, and the best methods of conveying the water from its source or sources to the various fixtures. It will be necessary in doing this to calculate the amount of water approximately required in the whole institution for a given period, the amount of water necessary at each fixture, and the velocity and volume of the whole amount which must be delivered at a time. All of these depend upon exact scientific calculations for the size of pipe, the kind of pipe, the number of bends or turns, their size and character, the distance of the source of supply from a given fixture, the initial pressure at this source of supply, whether this is caused by pumping or direct pressure, or by the pressure exerted by the weight of the water.

The loss of head of water for bends must be calculated by given formulæ. For straight pipe, the resistance due to friction is in direct variation to the length of the pipe and "friction varies

inversely as the diameter of the pipe, and varies almost as the square of the velocity, and is entirely independent of pressure."

Water Hammer.—Having determined the size of the pipe, the pressure and velocity therein, it is necessary to so construct the system that it will be both noiseless and free from the danger of bursting pipes and apparatus. The first requisite in guarding against this is to provide means to prevent excessive pressure in the pipes and system. This pressure is caused by the quick closing of cocks on fixtures, and so bringing the water flow to a sudden stop. Water which is moving through a pipe at a known velocity and with a given pressure will give an impact when the flow is suddenly turned off which is calculated at from four times to eleven times the initial pressure.

Mr. Cosgrove in "*Principles and Practice of Plumbing*" says in regard to this: "With a static pressure of thirty pounds per square inch and a velocity of eight feet per second, the maximum pressure due to water hammer when no air chamber was used was 320 pounds to the square inch, an increase in pressure of 290 pounds or an ultimate pressure of almost eleven times the initial pressure. At a velocity of four feet per second with all of the other conditions unchanged, the maximum pressure was about 135 pounds per square inch, or an ultimate pressure of four and a half times the initial pressure. With an air chamber of forty cubic inches capacity and a velocity of eight feet per second, the maximum pressure was about 230 pounds, or an increase of 200 pounds above static. When an air chamber of 320 cubic inches capacity was used, and with a velocity of eight feet per second, the maximum pressure produced was less than that produced with a velocity of 3.5 feet per second when no air chamber was used.

"It will be observed, however, that the experiment conducted with half-inch self-closing basin cock more nearly approaches the condition found in practice. In those experiments, the ultimate pressure was equal to about three times the initial pressure, while in a water supply system provided with adequate air chambers at suitable points, and fitted with slow-closing faucets, the maximum pressure due to water hammer should never exceed double the static pressure. The force of impact to a great extent is dependent upon the time consumed in closing the bibb. Thus, if the force of impact due to closing the bibb in one second equals 174.45 pounds, the force due to closing it in half second would equal 354.9 pounds, and to closing it in one-quarter second, 532.35 pounds."

Air Chambers.—To prevent this water hammer and exces-

sive pressure in pipes, air chambers are provided. These are usually enlarged pipes exactly designed and proportioned to receive the impact of water pressure. It is necessary to know the velocity of the water in the pipe, the size of the pipe and its length, in order to determine the size of the air chamber. Exact calculations are possible and are necessary. The air chambers have been used to some extent on fixtures, but these have usually been extensions of the supply with an enlargement just above the take-off of the chamber, and have had no relation whatever to the exact size necessary to adequately take care of the air pressure to overcome water hammer. Such air chambers when used on manifolds, in the rare cases where they have been installed, and at the terminal of mains from which branches have been taken,

FIG. 99.

have in almost all instances been far below what is necessary to relieve the pipes from excessive pressure.

In all air chambers provision should be made to give access for the air as water will absorb air and soon exhaust the air in the chamber. These chambers should be equipped with pet cocks for the smaller chambers and stop cocks for the larger ones, to permit air to enter. The pressure of the water should be directly upon the air chamber. This can best be accomplished by putting such chambers where they will receive the initial pressure, and

should never be placed in a horizontal position or at an angle. Air chambers should be placed in connection with meters to take the force of the water hammer from the delicate mechanism.

FIG. 100.

Each supply of fixtures should have an air chamber and such chambers should be placed on discharge and suction pipes to power pumps and on distributing drums. Two forms of these chambers are shown in Figs. 99, 100, 101, 102.

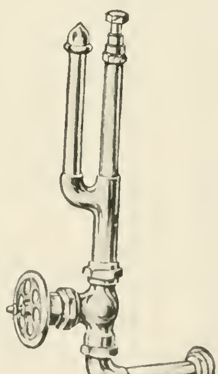


FIG. 101.

MATERIAL.—Material for pipes are of several kinds—namely, lead, iron, brass or white metal. As all pipes are subject to pressure and other stresses, they are made of different thicknesses of metal to withstand such pressure. Pipes should invariably be seamless except in iron.

The material to be used depends upon several conditions, pressure in the pipe, location of the pipe, the finish on the pipe.

LEAD PIPE.—The required thickness of piping and the material for such pipes is a matter of exact computation by formula. When the thickness of material is known, the exact stresses it will withstand can be calculated; and on the other hand, when the stresses are known, the proper thickness of material for pipes can be calculated. In such calculations the same general rules apply as would be employed in computing a structural member of the building, as described in the Chapter on Iron and Steel.

In all instances there must be allowed a factor of safety in calculating the size and strength of pipe. There are in hydrodynamics, as in steel, computations giving for live and dead loads. The dead load is the constant pressure in the pipe; the live load is one which is not constant, due to variations in pressure from

FIG. 102

one cause or another. The most serious of these variations is due to water hammer. The factors ordinarily allowed in pipes are the same as for structural steel—namely, six for live loads and four for dead loads.

Lead pipes come in different weights and thicknesses, and are usually used where such pipes come in contact with the ground or are run in damp places. Lead is also used for supplies, either painted or unpainted, but as they are subject to rough usage, and are pliable and soft, they are not as satisfactory as brass tubing, iron pipe, or white metal pipe for this purpose. Lead pipe is used where the corrosive action of the water would injure either the pipe or the supply if iron or brass were used.

The classifications of lead pipe and their grading from the light to the strongest pipes are aqueduct, extra light, medium, strong, extra strong, and extra-extra strong. The commercial varieties usually employed are the strong and extra strong. Most

municipalities have regulations requiring the use of extra strong in all work where lead pipe is put in.

WROUGHT IRON PIPE.—Like lead pipe, iron pipe comes in sizes and weights which are adaptable for any work. It is manufactured in two ways—by rolling the metal and joining the two edges of the iron, or butting them together, as it is ordinarily designated; and by lapping the edges over one another after they have been beveled. The butt jointed tubing is not as strong as the lap welded tubing, but as the former is made in small sizes only, this need not be taken into consideration. Iron pipe for

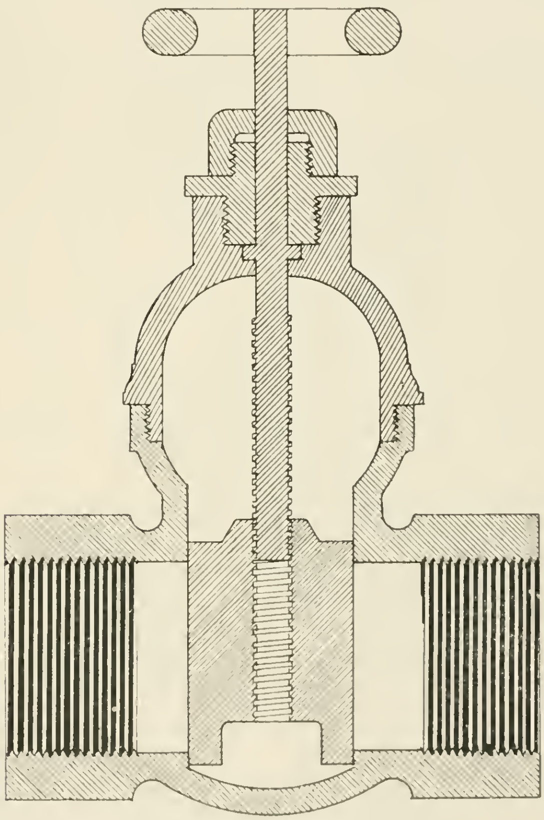


FIG. 103.

water supply is usually galvanized inside and outside, although it is also treated in other ways to prevent corrosion. Water which flows through pipes that are not thus protected is subject to discoloration.

The subject of pressure as applied to calculations for wrought iron pipe is as exact as for lead pipe.

Wrought iron pipes are used for water supply where such pipes do not come in contact with the ground. They are also used as supplies on fixtures, and for this purpose, when galvanized or painted on the outside are admirable.

Brass Pipe.—Brass pipe is calculated in iron pipe size and is seamless tubing made in stock lengths. It is used in the rough state, nickel-plated or polished, depending on its purpose and location.

There are several grades of brass tubing, but the ones ordinarily selected and best adapted to plumbing work are the standard and extra heavy tubing of regular temper.

Safe loads are calculated for these in the same manner as for other piping.

Fittings.—There are no fittings for lead pipe, all joints being soldered.

For iron pipe, malleable or gray iron fittings are used—the former for small pipe and the latter for larger sizes.

Brass fittings are made of cast brass and are either rough, polished or nickel-plated, as the case may be, to make them cor-

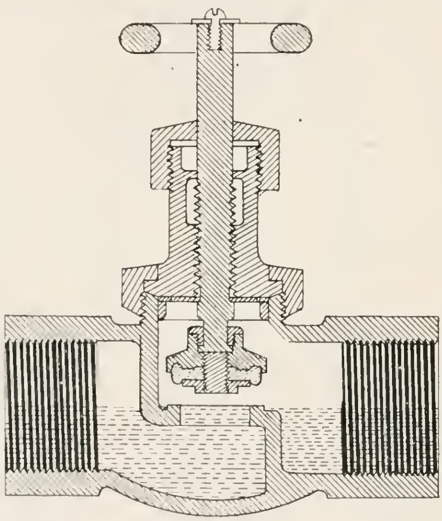


FIG. 104.

respond to the finish of the pipes to which they are connected.

Valves.—Valves are used in water supply to either control the water flow, to check the water flow, or to equalize the same. Gate valves, globe valves and angle valves are used to turn off or turn on the water. Check valves, as their name indicates, are to check the flow of water due to back pressure for one reason or another.

Gate Valves.—Fig. 103 shows a gate valve. This is the best type of valve to use on mains, as it seats tightly and positively when closed and gives a full aperture, and consequently full sweep to the water flow when completely open.

Globe Valves.—A globe valve is shown in Fig. 104. This type although used most extensively has these objectionable features

—diverting the flow of water, owing to its structural design; it can be put on the pipe in only one position; it is not reversible as is the gate valve; the disc of the valve closes on a seat against the water flow or pressure. In this type of valve the disc must

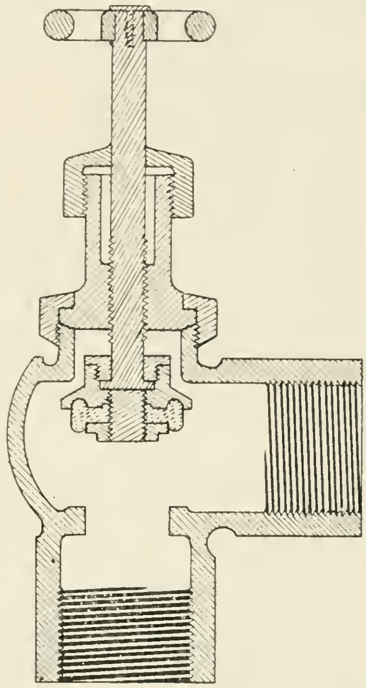


FIG. 105.

be renewed, as it is of soft material. It has been found that in valves of this pattern metal discs will not remain water-tight.

ANGLE VALVES.—Fig. 105 shows an angle valve, a type of valve which is placed on the supplies of each fixture. The usual position of such valves is shown in Figs. 101, 102.

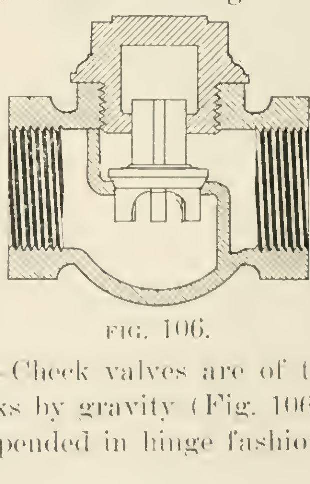


FIG. 106.

CHECK VALVES.—Check valves are of two patterns, those in which the check works by gravity (Fig. 106), and those in which a disc or gate is suspended in hinge fashion from the top of the valve (Fig. 107).

These valves are designed and installed into water supplies

to prevent water from flowing in more than one direction in pipes. This is necessary where there is a liability of back pressure. In the lift valve the check is raised by the flow of water and pressure under the check. The reverse flow is prevented by the pressure of water over the check. The same action takes place in the swing

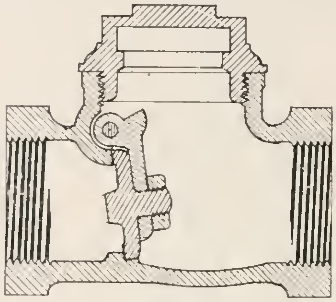


FIG. 107.

check valve, with the exception that the disc or check swings with the water pressure and flow, and closes against the back pressure. As will be seen, the latter form of valve gives a full opening as in the gate valve, and in the former a contracted opening results, as in the globe pattern valve.

COCKS.—The four general types of cocks now in use, each

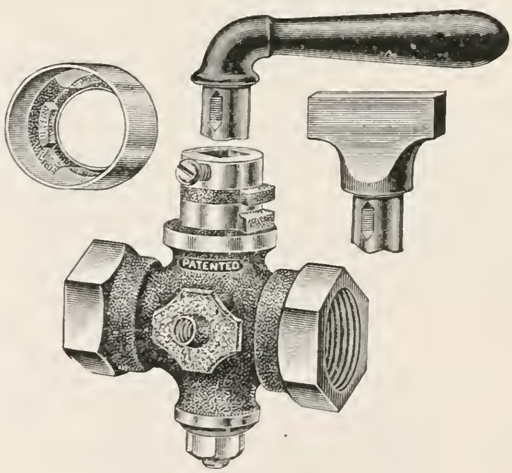


FIG. 108.

with its variations, are the ground key cock, the compression pattern cock, cocks in which Fuller balls are used, and cocks of the self-closing pattern.

GROUND KEY COCKS.—The first type, those with ground keys, are not recommended for hospital work, except where they are used as controlling valves on pipes, or in places where they are not used frequently. These cocks work metal to metal, and are consequently subject to the wearing away of the metal of the

key and the cock, which prevents a tight joint, and a consequent leaking of the faucet. They are not adapted to high pressure work. Moreover, since they are not provided with air chambers, as are the self-closing cocks, and owing to the rapidity with which they can be closed, their use might give rise to serious derangement of pipes and fixtures (Figs. 108, 109).

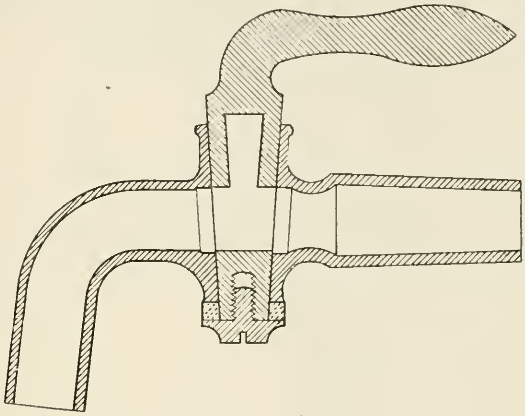


FIG. 109.

COMPRESSION COCKS.—Compression cocks are ordinarily used on laundry trays, sinks in boiler rooms, and kitchen sinks (Fig. 110), although there are types of such valves which are used on lavatories (Fig. 111). They operate on the same principles as

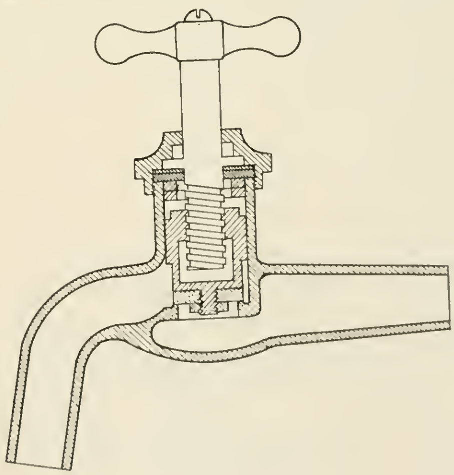


FIG. 110.

the globe pattern valve. They can be kept in good working condition, as they have a soft disc which closes on a metal seat, this disc being removable and easily replaced. There is a stuffing box at the top, as well as a packed joint to prevent leaking around the stem.

This form of cock is particularly adaptable to high pressure work, owing to its slow closing action.

Fuller Cocks.—Fuller faucets are adaptable to low pressure work only, and in all cases where they are used the supplies to fixtures must be equipped with air chambers, owing to the rapidity with which this type of faucet can be closed. Fig. 112 shows the method of working these cocks; the rubber ball presses against the seat. There are many types of these faucets, some of which are shown in Figs. 113, 114.

FIG. 111.

Self-Closing Cocks.—Self-closing faucets are those which close by spring when the handle is released. They are used to effect economy in water consumption, and for this reason where practicable are adaptable to hospital purposes. They are especially serviceable where water is scarce, or pressure and quantity

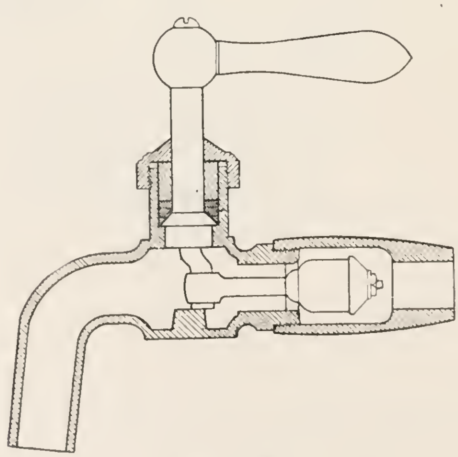


FIG. 112.

depends on tank supply for day use, the tank filling at night, and where water is metered and the rate is high for water consumption. Such faucets could not be used on fixtures where continuous supply was necessary, as at operating sinks where foot

or knee pedal attachments were not in use, as shown in Fig. 115.

The type of self-closing faucet, in which the working parts do not come in contact with the water, and which are made with an air chamber in the faucet, are the best, as shown in Figs. 116, 117, 118.

FIG. 113.
Low pattern Fuller faucet.

PRESSURE REGULATORS.—All systems of water supply which are supplied from outside sources in which high pressures are maintained, or sources which are subject to such pressure, should

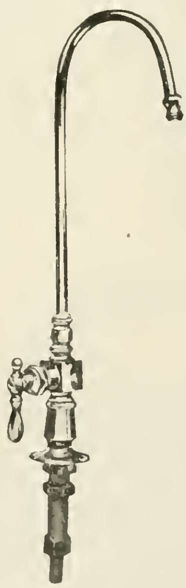


FIG. 114.
"Goose neck," or pantry sink Fuller faucet.

be equipped with pressure regulators. These keep the water in the building at normal pressure at all times, except when the force outside is below the normal inside, irrespective of the outside pressure except as stated.

A relief valve, or a safety valve, should be used in connection

with such pressure regulating devices to afford a means of relief to the water system in the hospital, which might be necessary if the hot water in its heating apparatus caused excessive pressure.

SERVICE CONNECTIONS.—Service pipes for hospitals should be

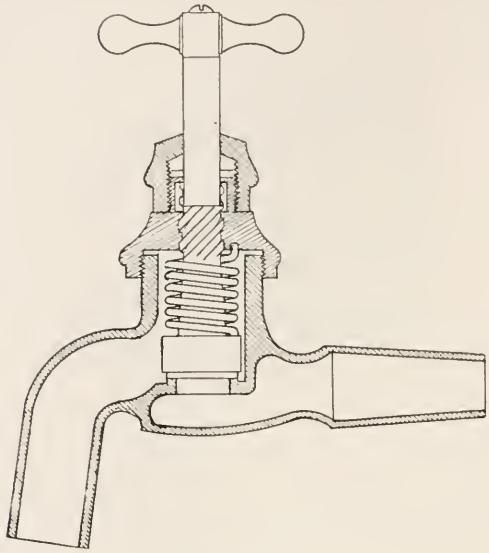


FIG. 115.

made in such manner that the maximum supply of water is at all times available. As most municipalities have regulations which do not permit of a larger tap than three-quarters of an inch to the mains, connections must be made with multiple service con-

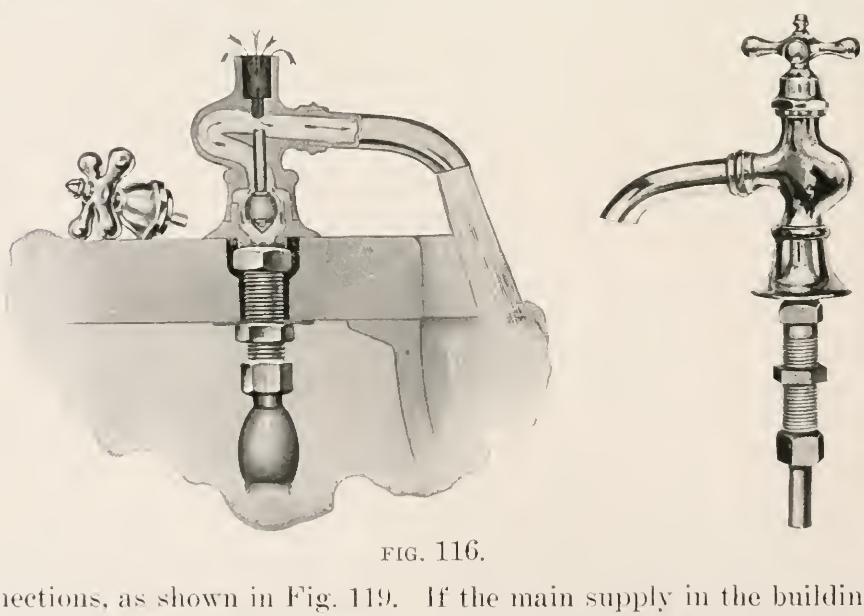


FIG. 116.

nections, as shown in Fig. 119. If the main supply in the building is over 2½ inches in diameter, the special fittings referred to must be used when the street mains are only of moderate size.

For small service pipes and when the street main is extremely large, the multiple connection should be used. Since the feeds or taps to the main supply are small, the item of friction in these must be considered.

Water in a pipe three-fourths of an inch in diameter at a given velocity will only flow with a capacity one-quarter of that in a pipe of one and one-half inches in diameter. These calculations are based on the "equations of pipes," and such tables should be carefully consulted in making multiple connections. In hospitals where the supply of water must be constant, there should be two service pipes, each of which would be capable of supplying the building, and if possible should be taken from the mains in different streets. These supplies should be cross-con-

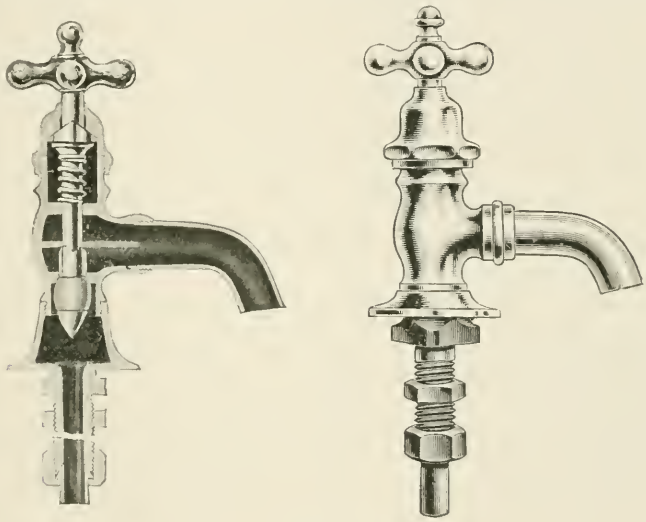


FIG. 117.

nected in the building. All such service pipes should be equipped with either stop cocks or gate valves.

Size of Pipes.—The water pipes in hospitals should be of such size that the supply of water is at all times plentiful at low pressure to all fixtures. If small pipes are used there will be the consequent annoyance of being unable to draw water at one fixture when the faucets of another are in use. Moreover, in the use of small pipes the system is not quiet in working. Pipes in hospitals need not be of such size as to supply all fixtures at one time, as all such fixtures are rarely in use simultaneously. All that is necessary is to design the system so that any one group of fixtures may be adequately supplied, and it will be found that such provision will fulfill all requirements.

Manifolds.—In buildings in which the supply of water to all fixtures is from direct pressure from the street main, manifolds

should be installed so that all of the valves controlling the water in the building are located at one point, thus facilitating the shutting-off of water in any section of the building from a central point.

In multiple storied hospitals in municipalities there is, with

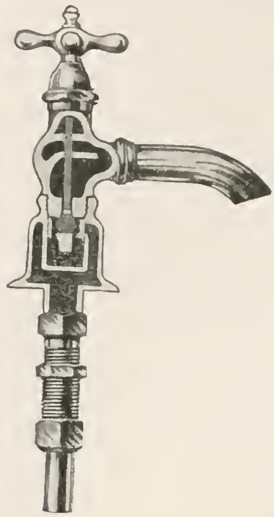


FIG. 118.

but few exceptions, not sufficient pressure from the water mains to give an adequate supply of water to the upper stories, and for this reason tanks are necessary.

In smaller hospitals it is not always possible to follow elaborate systems for the simplifying of water supply, but no hos-

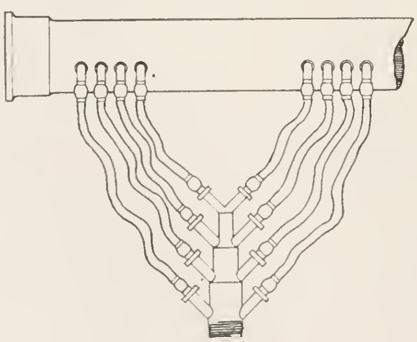


FIG. 119.

pital is too small to follow some simple system, which would make such a supply accessible and easy to handle.

Pipe Shafts.—In hospitals of three or more stories there should be provided shafts for the carrying of pipes. These shafts should be made of such size that all parts of their contents are accessible, and should be so constructed that they will open from floor to ceiling with hinged doors at their point of access. The

running of pipes in an erratic manner from supply to fixture may be somewhat more economical in first cost—namely, in the installation—but the amount of tearing up and replacing, and the consequent inconvenience which occurs when even one pipe must be removed for one cause or another, would more than pay for a systematic grouping and running of water supply.

Storage Tank Systems.—In the use of storage tank systems two methods are usually employed. The first applies to localities where through the excessive use of water during the day, the pressure is so reduced in the street mains that water cannot be drawn conveniently or at all in the higher stories. In such instances the night pressure is usually sufficient to fill the tank, which is put in the attic or in a pent house on the roof, thus giving sufficient water during the entire twenty-four hours. In such systems it is the custom to arrange the water supply, except for the hot water, so that the lower stories are supplied by the direct pressure, and the upper stories from the tank. In this system it is absolutely necessary to supply the heater for the hot water supply from the tank at all times, for obvious reasons—viz., first, that were this not done there would be no hot water supply for the upper stories during the period of low pressure; and, second, that there would be great danger of mishap to the water heating apparatus should the supply of water at any time be shut off.

It is necessary in hospitals when the lower floors are supplied direct that provision be made so that in case the water from the street main becomes insufficient, the supply from the tank will automatically give a supply of water to such lower floors.

In larger hospitals, where the water consumption is relatively great, the system of supply is shown in Fig. 120. In this system a pump forces the water to the storage tank in the attic, which tank may be supplemented by as many overflow tanks as are required to give a full quantity of water for at least twenty-four hours.

Pumps.—Pump for this work can be one of the many types employed, but an automatic, motor-driven, triplex pump is the most economical and the most positive in operation. The triplex pump will sustain the column of water to the tank to better advantage than any other form.

In the use of pumps for water supply it is always well to take the water from a tank placed close to the pump.

Tanks.—If steam pumps are used surge tanks or suction tanks must be employed. This is done so as to prevent the reducing of the pressure in the mains, and to prevent damage to the water supply system. These surge tanks should be made large

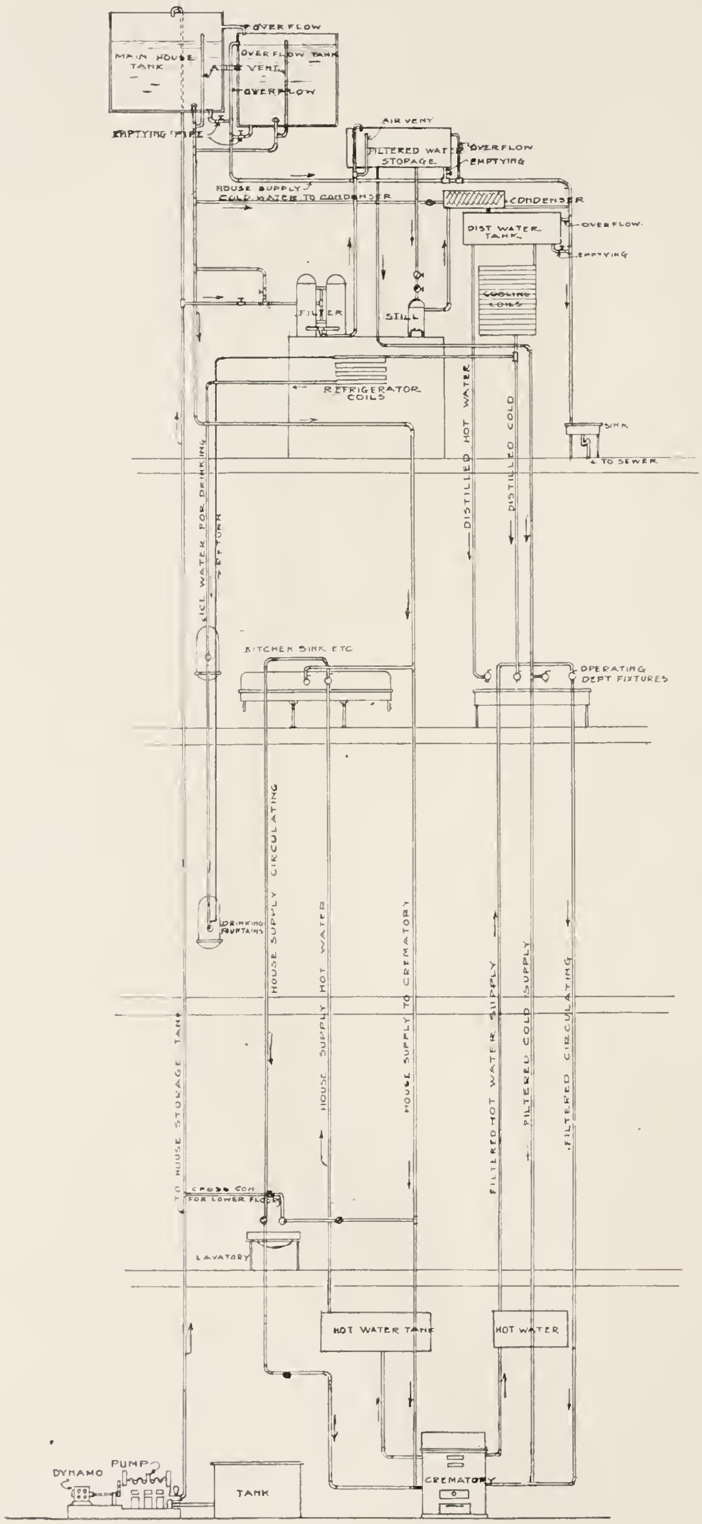


FIG. 120.

enough to hold at least one day's supply, if possible, large enough for two or three days' supply.

The house tanks should be located well above the highest fixture in the building. The minimum distance between such fixtures and the lowest tank should be at least ten feet. These tanks, and as much of the apparatus as can be conveniently placed, should be in a separate room or pent house, built in such manner as to prevent freezing of the water. This makes it possible to systematize the water supply.

Owing to the amount of water that is used, it is often necessary to supply auxiliary or overflow tanks. These should all be connected below the main tank with the main house supply.

All tanks should be supplied with an overflow pipe, which is equal in size in its discharge to the greatest quantity of water which is brought to the tank by the supply.

House tanks should also be provided with a vent pipe on the house supply, and an emptying pipe from the bottom of the tank connected to the overflow with a valve so placed that the entire tank can be drained. The supply pipe to the house should extend a short distance above the bottom of the tank inside of same, so as to prevent the sediment from entering the supply. These overflow pipes should be run to the roof, or preferably to the nearest sink. They should never be connected with the drainage system direct.

The size of tanks can be safely figured in their capacity in hospitals at one hundred gallons of water per day per capita. As shown, the auxiliary tank as well as the distilled water tank are equipped with overflow and emptying pipes. If all of these discharge into one pipe (see figure), this pipe must be increased relatively for each tank as the latter discharges into this pipe.

As shown in the illustration, for a system of water supply, the apparatus for which is herein described, the water is brought into a storage tank, which is made of steel, and from this is raised to the house storage tank by the direct connected triplex pump.

A check valve should be placed in the riser so as to take as much load off the pump as possible. In this system an auxiliary tank appears which is equipped similarly to the main house tank, is supplied with water by the overflow of the latter, and is cross-connected to the main house supply. A branch from the main riser to the storage tank, as also a branch from the main house supply properly cross-connected, is run to the filter. The filtered water is taken from this filter to a storage tank. From the main house supply is run a branch at least two inches in diameter, which is connected to the garbage crematory or to a suitable heater. From this main house supply are also taken the branches

for the cold water supply for the slop sinks, kitchen sinks, water closets, slop hoppers, bath tubs, and lavatories. From the garbage crematory for the house supply is taken the hot water for the above fixtures, except the water closets, with proper return to the heater for complete circulation.

From the filtered water tank is taken a supply to a manifold as in the case of the cold water and hot water house supply, and from this manifold are taken the pipes to supply the sinks in the operating rooms, dressing rooms, sterilizing rooms and anesthetizing rooms, with cold filtered water. The filtered water supply is run to the garbage crematory through a separate coil, and the above fixtures are supplied with hot water in this manner.

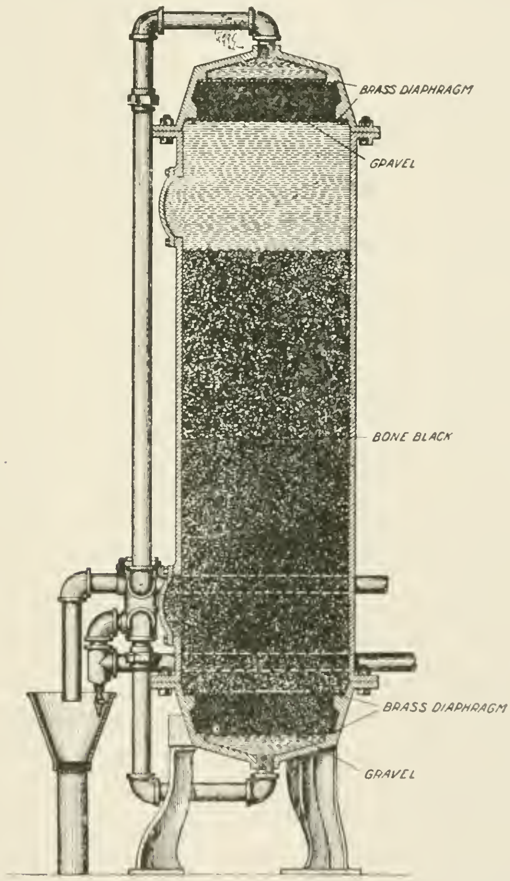
There must be a return or circulating pipe on all hot water feed pipes, so as to give a continuous supply of hot water at any fixture immediately upon the opening of a faucet. This can be accomplished to better advantage by running the pipes up to supply one set of fixtures, and returning the pipes to supply another set, and then return to the heater as shown.

From the filtered water supply a branch is taken to a distilling apparatus, a pipe leading from this to a condenser. This condenser is operated by a flow of cold water from the main house supply, and the discharge of this water can be either into the discharging pipe, or it can be directly connected to the hot water supply as an auxiliary to the hot water house supply, the water being heated in the process of condensation. The condensed water flows into a distilled water tank, which has an overflow and discharge pipe as for other tanks. The distilled water in the tank is hot and is piped directly to the distilled water fixtures in the operating and dressing rooms, etc., as described. There is also a pipe from this tank to cooling coils, which are so placed that the water in them is cooled by air or by water from the main house supply running over these coils. In this manner the sinks in the operating department are supplied with cold distilled water. From this supply is taken a branch which is run through coils placed in the refrigerator to supply the drinking fountains, and such other fixtures where drinking water is used.

It will be necessary in order to have no waste of the iced distilled water that a circulating pipe be run to the farthest fixture, and all intermediate fixtures connected with return stubs to the main return pipes.

By so doing there is a continuous circulation which makes it possible to draw cold water immediately instead of emptying the entire supply pipe wherein the water has become warm by standing.

Filters.—The filter should consist of two cylinders connected by one operating valve or manipulator. The construction is shown in Fig. 121. In each cylinder there are two diaphragms about two inches apart, made of brass wire cloth backed up by a grating. The space between the diaphragms is closely packed with sea gravel, which confines the filtering bed in the cylinders. Animal charcoal, or bone black made by calcination in inclosed vessels, is the material used for filtering. This is a purifying as well as a clarifying agent, and, owing to its buoyancy, is easily cleaned. Owing to the fact that fully two-thirds of the mass of this material is occupied by interstices and pores, as against only one-third in



Section of Cylinder Showing Construction

FIG. 121.

sand, such as is found in sand filters, it is possible to do the filtration without the use of coagulants. Alum is necessary in sand filters as a coagulant to gather this sediment in such coarse particles that it will not pass through the interstices. The quantity of alum necessary to clarify water varies from day to day with the changing conditions of the water supply. It can only be

determined by chemical analysis, which, of course, is not practicable under ordinary circumstances. Any excess of alum in water used for drinking is prejudicial to health, and as there would certainly be an excess almost constantly, its use in filters is condemned by all medical authorities. Filters in which alum is used are all the more dangerous because they deliver water that is brilliant and sparkling, and there is a popular tendency to regard clear water as pure. That is one reason why too much stress cannot be laid upon the danger of alum clarified water. Neither does the alum process render water suitable for bathing, laundry or manufacturing purposes. It makes the water "hard," releases free sulphuric acid in large quantities and greatly increases the incrustation when the water is used for steam boilers, causing diminished efficiency and higher fuel cost.

All filters should be constructed with a deep filtering bed, so that the water will remain longer in contact therewith and thus become clearer and purer. Sand filters are impaired in their usefulness by severe changes in temperature.

In using the double cylinder filter the cleansing process can be made automatic, and does not require the turning of the crank or other manual labor to clean the filtering bed. This is an advantage also over the stone filter, in which the filtering medium must be scraped by the turning of the stone and the consequent wearing thereof, and causing in time the replacing of the filtering stone.

The cleaning process is as follows: The filtered water from one tank is run through the opposite tank by turning the manipulator in a position where this result is obtained. The water filtered in the first cylinder washes all of the impurities from the filtering bed of the second by reversing the flow, the water from the second cylinder being carried into the waste.

In using bone black filters no chemicals are required; each cylinder is washed with filtered water only; the supply of filtered water is not cut off during the washing process. The water can be singly or doubly filtered; the bacterial efficiency is not reduced after washing. Bone black also removes sulphuric acid and iron, and in consequence pipes and fixtures are not affected by these.

Garbage Crematories and Water Heaters.—The object of the garbage crematory is to supply a cheap and effectual method of disposing of refuse. Where there is a large amount of such refuse the consumption of coal for the raising of water to the required temperature for use in a hospital is small. None of these crematories, however, will operate on refuse consumption alone,

and it is necessary to supplement this by coal. In large plants the water from these crematories is used for feed water.

Dr. McCullom says: "Twenty-five years ago the destruction of garbage by fire commenced to receive the attention of physicians and sanitary engineers, and, like every advance in science, this method was bitterly opposed on economical principles, as well as on account of the offensive odors resulting from combustion. In the refuse from wards, we have only to deal with rubbish and garbage, such as paper, soiled dressings and mattresses. Much has been said regarding the expense of the disposal of refuse by cremation, and an important factor in increasing the expense is the cost of collection, but this does not apply to hospital refuse, as it is not transported any distance.

"The object to be sought is a cheap, effectual, and not too complicated method of disposing of the refuse from the wards. Where a large amount of refuse is to be destroyed, the heat generated by its combustion can be utilized to a certain extent in the production of steam or hot water."

In commenting upon the necessity of cremation of garbage and refuse from hospitals for treating infectious diseases, Dr. McCullom further states that "No case occurred within an eighth of a mile of the hospital. Sixty-eight cases occurred within a quarter of a mile; within a half mile seventy-one cases; seventy-five cases within three-quarters of a mile, and seventy-two cases within a mile. Without going into this subject too much in detail, it is sufficient to say that, during the past ten years, in which time more than 24,000 cases of infectious diseases were treated, in no instance can the infection be traced to the hospital. The result is due, without doubt, in a great measure, to the fact that all the refuse matter from the wards is burned on the premises; for there can be no doubt that where hospitals for infectious diseases have apparently been spreaders of contagion, there has been lack of care in the disposal of the refuse."

The subject of garbage cremation for the supply of feed water to power plants, commonly known as thermal storage, is too comprehensive to explain in this volume. There are books on this subject which give the entire detail of the ways and means of obtaining results. Such furnaces are too large for the ordinary hospital, and are used only where high pressure plants are installed and forced drafts can be obtained readily. Crematories installed for the sole purpose of destroying refuse without reference to the economic principles of conserving the heat are not recommended. Crematories will serve the purpose of refuse destruction as well when the products of combustion are utilized

to heat the water supply, as they will when all of this heat is wasted.

All crematories constructed for the utilization of the heat have the same primary principles as those which are made for destruction alone—namely, the converting of refuse into fuel; that is, first drying the garbage and refuse and then burning it. In the types ordinary to hospitals, crematories are built with two chambers, the upper being divided from the lower by garbage grates. These crematories come in all sizes, from those used in the smallest to the large double crematories for the largest institutions.

They are built in several ways, either of steel with an inner and outer shell, or brick, set in the same manner as are furnaces for boilers. The steel double shell type has a water space around the entire crematory between the shells. The brick set type is made with water tubes in the lower or combustion chamber, which extend along both sides and rear. Of the latter there are also varieties in which there is a garbage pan fixed in a slanting position, upon which the garbage and refuse is placed through a side door. The coils are carried along both sides of the pan and are crossed underneath in the rear, in order to absorb the heat from refuse and garbage, as well as the heat from the coal, as it travels through and over the garbage pan. The principle is to gradually burn or consume the refuse at the same time that the products of combustion are absorbed on their travel.

In the ordinary type the garbage and refuse is placed upon the bars, and the heat from the fire in the lower chamber dries this until it is converted into fuel.

Crematories are built with continuous circulating coils, or with coils connected to the inner shell, if they are built entirely of steel. The upper or garbage grate should be hollow tubing, the lower grates of the ordinary rocking kind. There should be sufficient cleanout doors in all crematories, and these and all other doors in the apparatus should close tightly. A good sized chimney or flue must be provided so as to give sufficient draft to make the combustion complete, and to carry off the surplus gases.

Where there are two sets of coils necessary, as in heating water for house supply and the filtered water, the crematory must be of sufficient size to do this work properly. In this type the coils are laid alternately.

The furnace for the double system could be of the all-steel pattern, in which the space between shells could be utilized for one system with the garbage grate as auxiliary to this, and separate coils put into the furnace for the second system. It will be

found possible in some cases that after the fires in crematories are started the refuse will supply sufficient heat for all purposes, but such cases are so rare that they are not to be taken into consideration. Coal or wood consumption is necessary, the advantage in crematories lying in the fact that the saving in such fuel is considerable.

WATER SUPPLY FOR SMALL HOSPITALS.—Water supply for small hospitals may be obtained as described for larger hospitals in simplified form. A storage tank can be placed in the attic to be filled by the municipal supply, by small electric pumps, or by wind pumps. Gas and gasoline engines are not recommended for hospitals, as they are noisy in operation and are not wholly dependable.

In the installation of systems for smaller hospitals the first requisite is a plan for the general layout and distribution which

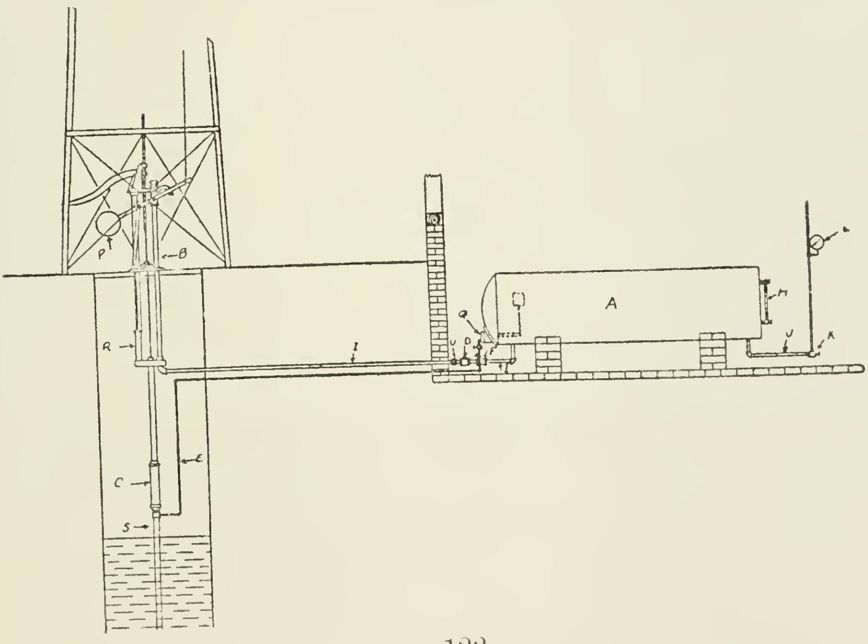


FIG. 122.

is economical and direct. What has been said of such systems for larger hospitals applies as well to the smaller institutions.

OUTSIDE TANKS.—Storage tanks of the ordinary type placed over a wind pump are not recommended, as there is always a liability of freezing in winter, and moreover in summer the water from such tanks is warm. Provision should be made in such a system for placing the tank in the attic of the building.

TANK SYSTEM.—The best method for obtaining water where there is no municipal supply is by the pneumatic tank system. This consists of a tank into which is forced water under pressure,

either by wind, electric pumps or gasoline engine and pump. The general operation of these systems is sure and direct, and they are besides very simple in installation and maintenance, as shown in Fig. 122. This outfit should be connected as shown in the above illustration. Air may be admitted to the tank by opening the pet cock Q. This will allow the air to pass through the air pipe E into the suction pipe S. From here it is pumped into the tank by the pump cylinder C and pump B. The air pump E must join the suction pipe S above the water level in the well, and the cylinder must not be under water.

When the system is first installed enough water must be pumped to seal the openings on the bottom of the tank. The valve Q is then opened and air pumped until the gauge shows a pressure of ten pounds. This may take some time, but unless air is allowed to escape from the tank it need not be done again. The air valve should then be closed and water pumped into the tank. When the tank is half full of water the pressure will be 30 pounds. This is the correct proportion. Any time that the tank may be half full of water, the pressure gauge should register thirty pounds, and if it is less, the pet cock should be opened and air pumped until the gauge shows 30 pounds pressure. Either a regulating cylinder or a relief valve should be used upon the system to prevent excessive pressure upon the pumping fixtures. When a pressure of 50 pounds is attained the regulating cylinder R will pull the windmill out of gear, thus limiting the pressure. The weight P will pull the mill into gear again when the pressure has decreased.

FIXTURES.

Location.—In selecting fixtures for hospitals, it is highly essential that only those be installed that have been found to be specially fitted for their ultimate purpose, and which may be accomplished without sacrificing their artistic effect. While in no way disparaging the effort toward sightly and artistic installations of fixtures, showy fixtures put in with these objects in view are to be discouraged. There are two tendencies which are equally bad—the one results in show without utility, greatly increasing the cost of keeping clean; while the other tendency is to secure only utility, and to make every detail absolutely plain, giving the institution a prison-like appearance that repels the very class of people that should be attracted and that can be most benefited if attracted. The main object to be attained is the placing of inexpensive, thoroughly practical, handsome and efficient fixtures, which can be easily cleaned and controlled.

Fixtures may be grouped as follows:

1. Bathroom.
2. Toilet room.
3. Operating room.
4. Kitchen department.
5. Laundry.
6. Domestic supplies.
7. Laboratory.
8. Hydro-therapeutic.

In the classification of bathroom fixtures would be water closets, bath tubs, slop sinks, slop hoppers, individual laundry tubs and shower baths not therapeutic.

FIG. 123.

Toilet rooms—Lavatories and individual water closets.

Operating rooms—Sinks for these, dressing rooms, anesthetizing rooms, sterilizing rooms.

Kitchen department—Kitchen sinks, butler's pantry sinks, and vegetable sinks.

Laundry—Laundry tubs.

Hydro-therapeutic—The entire equipment for such rooms.

Domestic supplies—Drinking fountains.

While it is possible and often preferable to divide the fixtures —namely, to place them in separate rooms, as, for example, slop sinks and slop hoppers—they are here classified as stated because

they are more generally placed in the bathroom, as shown in Fig. 125.

Private bathrooms in connection with suites or single rooms would come partly under the classification for toilet rooms, as lavatories are placed in these instead of sinks.

FIG. 124.

In operating rooms, dressing rooms, etc., as classified, as also in general bathrooms, lavatories should never be used. In bathrooms the fixtures can be arranged as shown in the illustration.

Bath Tubs.—The bath tubs should always stand free so that they are accessible from all sides. Such tubs can be of porcelain

or enameled iron. In either case they should be tubs with solid bases, extending below the finished floor, as shown in Fig. 123, with an enameled iron tub, and Fig. 124, a solid porcelain tub.

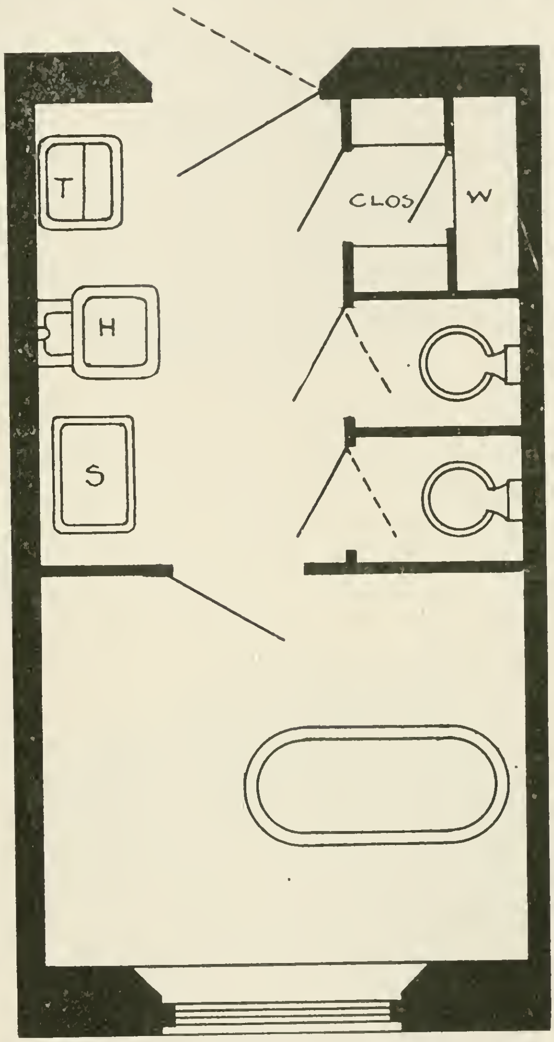


FIG. 125.

These illustrations merely show the method of setting: for location of such tubs, see Fig. 125.

Porcelain tubs are in no way superior to good enameled iron tubs, and are considerably more expensive.

The fitting for tubs should consist of bell supply fixture and standing waste, as shown. This leaves the entire inside of the tub free and gives easy access to all working parts. Moreover, the standing waste can be easily removed and cleaned. All fittings for these tubs should be made of nickel-plated heavy brass tubing and brass castings, or of white metal tubing and castings. The tubs should be trapped, as should also each fixture throughout the

hospital. Bath tub traps are of two kinds, the drum trap of lead or brass, which is set below the floor level with a trap screw on a level with the finished floor; and the nickel-plated brass trap, which sets above the finished floor, as shown in Fig. 126.

Water Closets.—Water closets are of two types—those with an individual tank for each closet, and those which operate by

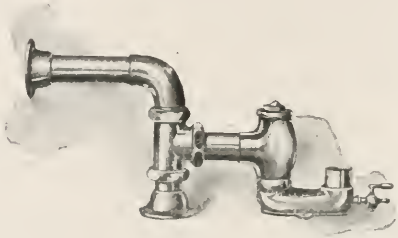


FIG. 126.

pressure from a main roof tank, or by direct pressure, if this is sufficient. All water closets without exception in hospitals should be siphon jet closets. For sanitary reasons all closets should be of the wall type, as shown in Fig. 127. This closet sets completely free from the floor and close to the wall and should be set into the tile or marble wainscot. In setting closets of the floor type,

FIG. 127.

they should be secured to the floor and to the soil pipe, as shown in Fig. 128, or in Fig. 129. The former consists of a conical shaped asbestos gasket, which assumes an inclined position between the connecting parts, becoming a powerful compressive lever during the tightening process, forcing it against the closet outlet, and against the wall of the floor flange, making a positive gas and water tight joint, without the use of rubber, putty or cement.

Fig. 129 shows a closet screw connection in two parts, the lower portion of which is fastened to the floor by means of screws and soldered to the soil pipe. The upper half is connected to the bowl, and a specially prepared asbestos washer is forced between the

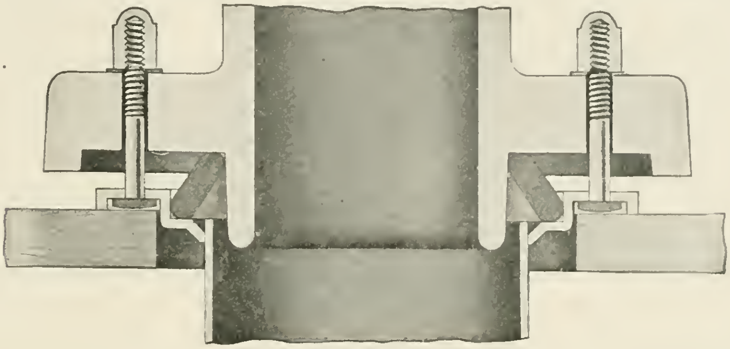


FIG. 128.

earthenware and brass connection. The two sections of the connection are then screwed together until the closet is flush on the floor surface. While enameled iron seats are the most sanitary to use on hospital water closets, they are objectionable, owing to the fact that they are exceedingly cold.

In using the wall form of closet, provision must be made for

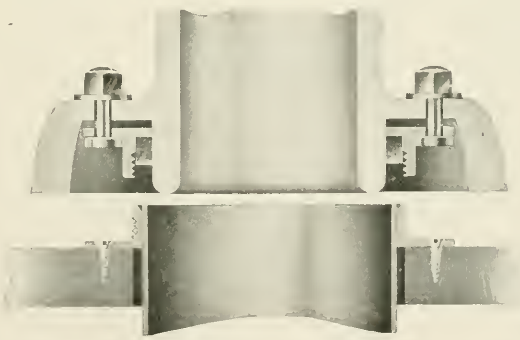


FIG. 129.

bolting the fixture to the wall, the connection being the same as described for floor closets, shown in Fig. 129.

The individual tank closet needs no special mention, except that the flush pipe from the tank to the closet should be at least one and one-half inches inside diameter. Either the tank or push button closet can be operated automatically.

Where the water supply is sufficient at all times the push button or lever type flushing valves are recommended. The flushing valve is the most economical form of all devices in its consumption of water. Supplies to these valves should never be less than one and one-half inches in diameter, and two-inch pipes are preferable. The water closet should invariably be made of

vitreous ware. The old style enameled iron closet is neither sanitary nor practicable.

Slop Sinks.—Slop sinks should be sufficiently large to conveniently admit a large pail. These can be of porcelain or enameled iron, but owing to their rough usage the latter is preferable. These sinks should be equipped with a strap standard, as shown

FIG. 130.

in Fig. 130. They can be made with a brass ring to protect the enamel, but with ordinary care this would not be necessary. The water supply to these sinks should consist of a combination faucet of heavy brass, with a long spout with a bucket hook, and the entire fixture firmly braced by a wall support. The sink should have a plug strainer, which will admit of its being filled.

Slop Hoppers.—These fixtures in their improved form have but recently been introduced for hospital use. The old type had not a water seal and it was impossible to dilute the contents of bed pans which were poured into them, and in consequence they were extremely malodorous until they were flushed, which could not be done quickly. In their present form, as shown in Figs. 131 and 132, the entire contents of the bed pan is diluted at once, and the flush being exceedingly strong carries away all the diluted material practically without odor. They should be so arranged as to have a long, continuous flush. Besides the strong siphon jet and consequent rapid discharge, there is a heavy flushing rim supplying a long and copious flow over the entire inside of the bowl.

These fixtures should always be made of vitreous ware, as is the case with water closets, for they are essentially an enlarged type of the latter, and should also be siphon jet in all cases. These

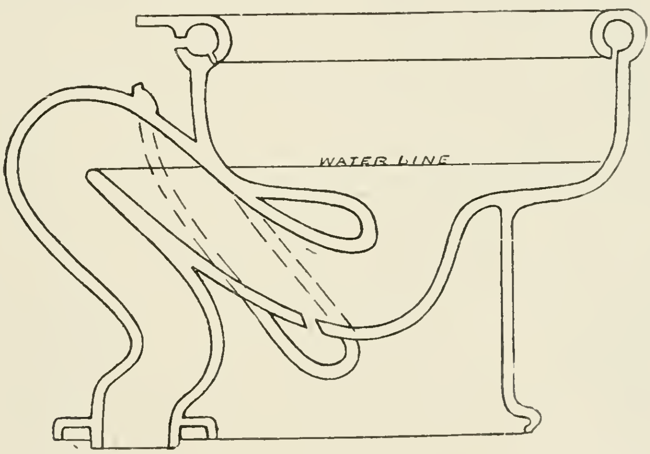


FIG. 131.

hoppers should be supplied with a long spouted faucet as described under slop sinks; the bucket hook may be omitted. These hoppers are secured to the floor in the same manner as described for water closets.

Wash Trays.—It is necessary in most instances to have at least one wash tray or tub on each floor. These can be made of porcelain, enameled iron or soapstone. They should be, as far as possible, in one piece.

Shower Baths.—The latitude in the selection of shower baths is so great that no attempt is made to describe fixtures, but general conditions are such that they must be carefully observed. It is recommended that showers of the simple and inexpensive forms be used in all bath rooms. These may consist of merely supplies with a head spray and an overhead ring with a curtain, the whole apparatus being placed over the tub. For special showers, such

as are used in doctors' dressing and toilet rooms, it is customary to install a full shower apparatus. The stall containing the shower can be built with sides of marble, slate or glass. The floors of such stalls can be built of any of these materials, or of tile or cement, but they must be properly countersunk and sloped to the central drain. It will be necessary in all instances to put under the floor of whatever material, except cement, a lead safing. The drain in these floors should be flush with the top surface, and of sufficient size to carry off the water as quickly as it flows to it. The shower to be used depends entirely upon the amount available for the apparatus.

FIG. 132.

It is customary to equip all showers with mixing chambers. These are in the form of cylinders, into which the hot and cold water are introduced from opposite directions, for the purpose of thoroughly mixing and producing a uniform degree of heat. If it were possible to control the flow of both the hot and cold water, the desired results could be obtained, but this is not possible, and therefore these chambers are practically useless. Several forms of these chambers have been invented to overcome the objectionable features, the government having adopted a non-scalding valve,

which consists of a single valve, so arranged that the cold water must be turned on before the hot water can flow. This makes it impossible to turn on the full head of hot water before the cold water is introduced into the shower, and so prevents accident through the introduction of scalding water. The valve is not wholly successful, however, in the absolute control of temperature.

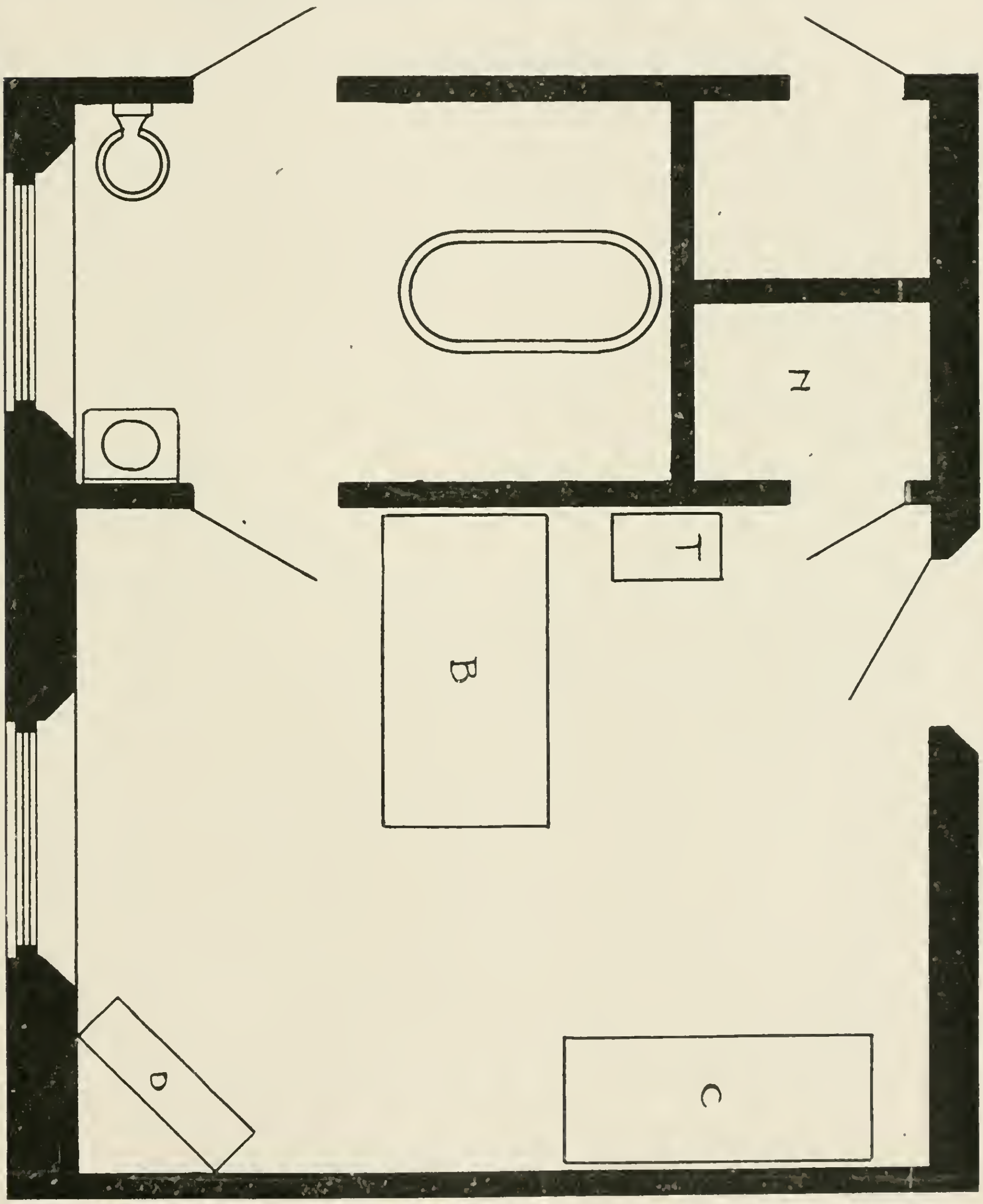


FIG. 133.

and while the safety feature is admirable, it lacks the requisites of a uniform temperature control. There has been introduced a system for the absolute control of water for showers, which consists of automatic controlling valves, arranged in such a manner

that the pressure is always uniform at the shower head. Aside from the automatic valves, the apparatus has a cylinder so arranged that the proper temperature of water is produced in this cylinder, the whole being controlled by one valve, which makes it

FIG. 134.

practically impossible for the temperature to vary, and also makes it a non-scalding valve, as the water first introduced into it is cold.

Lavatories.—Lavatories should be used, in hospitals, only in toilet rooms and private bath rooms in connection with other rooms. Fig. 133 shows the general arrangement of a private bath. Toilet rooms are placed in connection with administration rooms

Fig. 135.

and rooms for staff officers. They all follow the same general rules for fixtures. Tubs in private bath rooms should be the same as those in general bath rooms, following the same rules for the installation of fixtures. Water closets in these rooms should be

of the type best suited, but preferably the wall pattern as described, with lever or button valve supply, where sufficient water is available to operate these.

Lavatories for private baths and in other places in the hospital where these are used should be either enamel ware or vitreous ware. The latter are probably the best, as they are absolutely non-absorbent, and exceedingly durable. These fixtures should be of the integral type, in which the back, slab and bowl are cast in

FIG. 135A.

one piece, if they are to be placed against the wall, as shown in Fig. 134. If they are to stand free where the walls of the room are tiled, they can be of the type shown in Fig. 135.

These lavatories should be equipped with faucets as described, and traps of the non-siphon pattern, if these are necessary.

Operating Department Fixtures. For a number of years

there has been a growing tendency to exclude from the operating room all plumbing and lighting fixtures; in fact, stationary fixtures for any purpose that could possibly be dispensed with. This precaution came from the fear of having objects in the operating room which could not be easily and perfectly disinfected. There was also the fear of contaminating the operating room air by sewer gas, through the sewer con-

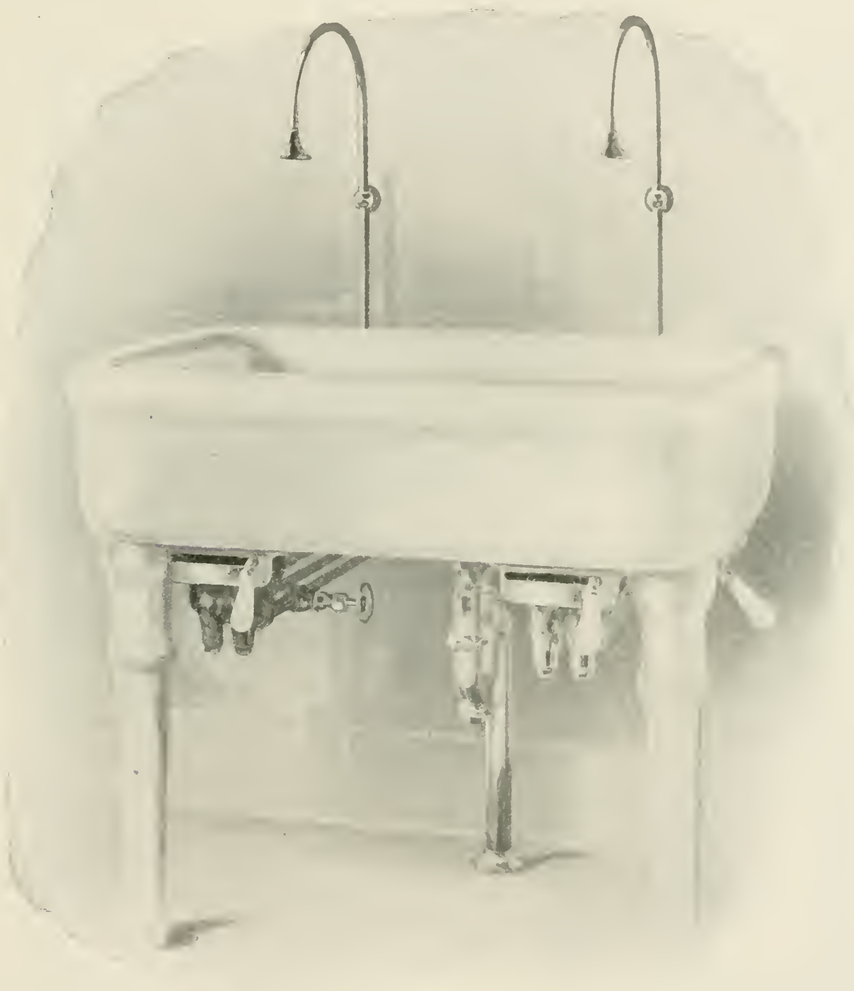


FIG. 136.

nections. These theories resulted in much inconvenience to the surgeon, his assistants and nurses, in the performance of their work during operations. The protection which modern plumbing affords against sewer gas infection is so perfect that this danger is now completely eliminated, and it is perfectly safe to have running water in the operating rooms. Aside from these fixtures, it is probably best to have no stationary fixtures except those

required for artificial lighting, which detail is discussed under separate heading.

In the operating and dressing rooms sinks should be of good size, made of enameled iron, vitreous ware or porcelain. These sinks should be deep so that the

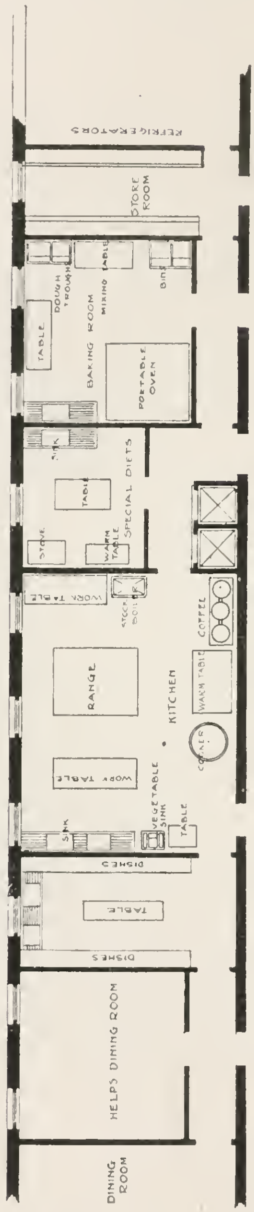


FIG. 137.

wash bowls can be placed into them conveniently. In operating rooms they can be arranged for hot and cold, filtered and distilled water, respectively. The supplies should be controlled by either pedal valves, as shown in Fig. 135A, or knee action

valves as shown in Fig. 136, and the water either distilled or filtered, both hot and cold, should be supplied to the sink through a single spout for each kind of water. The waste should also be operated by a pedal or knee action fitting.

There is a distinct advantage in using free basins in a sink instead of having stationary basins, because these loose basins can be easily sterilized by boiling and can be kept on hand in quantities.

It is really better to have the water come through one spout

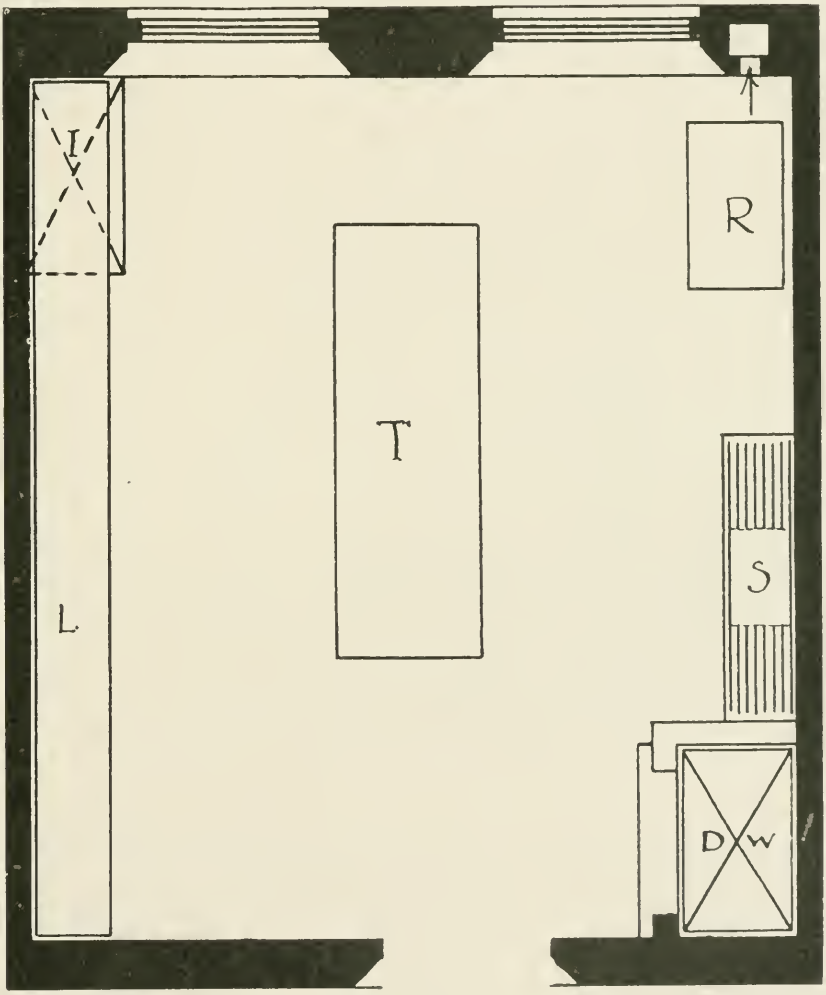


FIG. 138.

so that it can be mixed to make the proper temperature for washing under running water.

In the sterilizing room should be placed a sink for washing instruments, constructed like an ordinary sink, but which has instrument trays at either end, which are an integral part of the sink. The faucets should be placed high enough over this fixture

so that they do not interfere with the work. The traps for these sinks should be of the same variety as used for other sinks, as described under traps.

KITCHEN FIXTURES.—In Fig. 137 are shown model kitchen departments with all necessary fixtures and equipment for such rooms. The plumbing fixtures should consist of sinks for washing pots and pans, sinks for washing vegetables, and butler's pantry sinks. A sink should be placed in the baking room, also one in the special diet kitchen. In the illustration the ordinary diet kitchen is shown, and the only fixture in this is a sink with ample drain board space (Fig. 137). The ordinary diet kitchen is shown in Fig. 138.

SINKS.—The kitchen sink is probably the fixture which re-

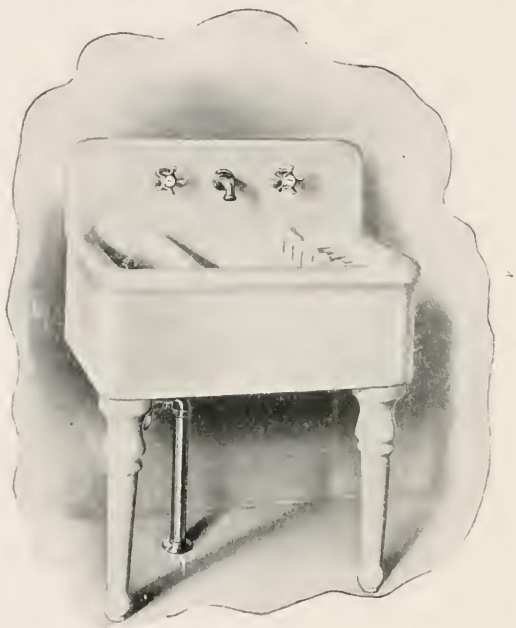


FIG. 139.

ceives the hardest wear of all those in a hospital. The washing of pots and pans is exceedingly hard on the surface of these sinks. They can be made of enameled iron, porcelain or vitreous ware, but the enameled is best adapted for this rough usage. All kitchen sinks should be connected to a grease trap, as described under traps, and should be supplied with hot and cold water through extension faucets. These faucets should extend over the sink to about eight inches from the back edge.

Drain boards for kitchen sinks should be made of either enameled iron or slate, which can be covered by rubber mats, or they should be made of well-seasoned ash with an enameled joint. These boards should be bolted and made especially for this purpose.

Vegetable Sinks.—Vegetable sinks should be of the pattern as shown in Fig. 139, having three compartments, the central one of which is very deep and used for washing the vegetables. At the

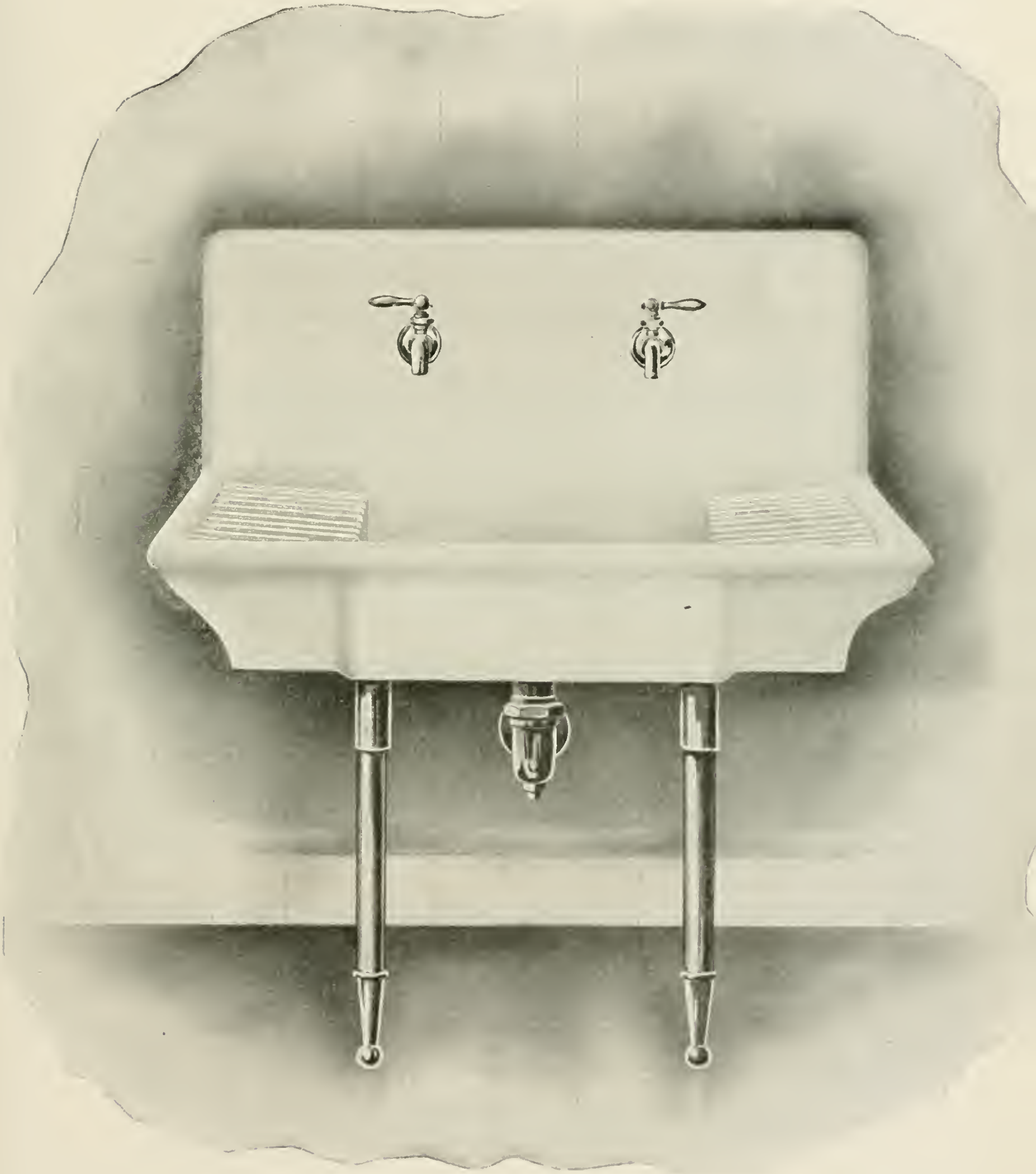


FIG. 140.

right of this is a shallow compartment in which are placed the cleaned vegetables, from which the water drains to the center

portion through the grates. To the left, divided from the center by a partition somewhat lower than the edge of the sink, is another compartment. The water from the center portion flows over this partition and drains out through a standing waste. The water from the center portion is drained out through a plug strainer after parings have been removed.

The left-hand section is also used for the washing of vegetables.

These sinks are made of porcelain.

Butler's Pantry Sinks.—Butler's pantry sinks are ordinarily made of planished copper, but are also made in all porcelain, as shown in Fig. 140. In the latter rubber mats should be used on the drain boards, and a wooden mat in the bottom to prevent breakage. In the copper sink the bowl is either spun in oval shape or

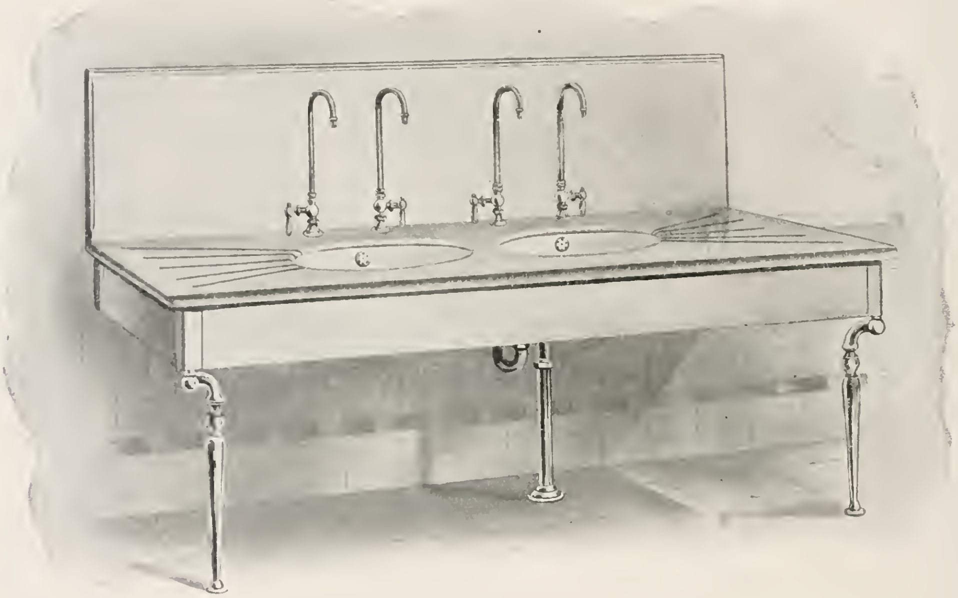


FIG. 141.

in square shape, in which the copper is blocked. In the latter pattern the copper is placed in a wooden box to give it a backing.

The drain boards are also of copper, grooved as shown in Fig. 141. The tops can also be made of marble when the sinks are copper. A full countersinking of the entire slab, with proper slope to drain, is preferable to the grooved top.

Supplies for pantry sinks are ordinarily Fuller pantry faucets as shown. The waste is trapped as described for other fixtures and connected to the waste stack. It is not necessary to equip pantry sinks with grease traps, as only glassware and silver are ordinarily washed in these sinks. If, however, the dishes are all

washed in one of these sinks, it must be equipped with a grease trap. The square pattern is fitted with a standing waste, and the sink itself holds the body of water for washing the dishes. In the oval pattern a plug and chain are used instead of standing waste. The porcelain sink has Fuller faucets as shown and can be equipped with standing waste, or the ordinary strainer waste, and an auxiliary pan used in the sink.

In the special diet kitchen and baking room an ordinary sink of enameled iron, porcelain or vitreous ware should be installed, as described for such fixtures, with sufficient drain boards for each.

Laundry Tubs.—These can be of buff porcelain, stone or enameled iron. In the individual laundry trays in bath rooms the tubs should correspond to the remainder of the fixtures, and should be of buff or white porcelain or enameled iron. These trays are admirable in many ways, and for this purpose are superior to the stone trays, as they are integral, while the stone trays are made of slabs with joints cemented. The cocks on these should be of the turn handle, ground key pattern, or compression cocks of the turn handle Fuller pattern. All wash trays are made with and without backs, but for hospital purposes the integral back tray is the best. Stone trays would have to be placed at a distance from the walls sufficient to run pipes, while in the tubs of other material the back is hollow to admit of these pipes and thus set close to the wall.

Tubs for the laundry can be of any of the materials mentioned, but the buff porcelain, enameled iron and stone trays are best. If the brass boiling pipe described under laundry equipment is put into the tub, the enameled iron or stone tub would be the best type to use.

The number of such tubs depends upon the extent of the remainder of the equipment. Where washing machines are used, three tubs will be sufficient in all instances. These tubs can be supplied with running wastes or each tub can be equipped with an individual waste. The running waste must have a good trap which can be readily cleaned, placed on the last fixture with the running waste attached to the trap with a good slope toward the first tub. The ordinary S trap, or non-siphon trap, will be sufficient in case individual traps are used. Running wastes and traps can be made of galvanized iron, rough brass or lead. Nickel-plated brass is not recommended for fixtures in laundries, owing to the steam and dampness in such places, causing corrosion and the constant care necessary to keep the nickel plating looking bright.

Drinking Fountains.—Drinking fountains are usually placed

conveniently in the corridor on each floor. Supplies for drinking water can also be placed in the main kitchen and diet kitchens, but this would only occur in larger hospitals. The fountain should be located in proximity to the diet kitchens. These fountains are of two types—the wall fountain and the pedestal fountain. The former are made for recessed fountains, as shown in Fig. 142, and

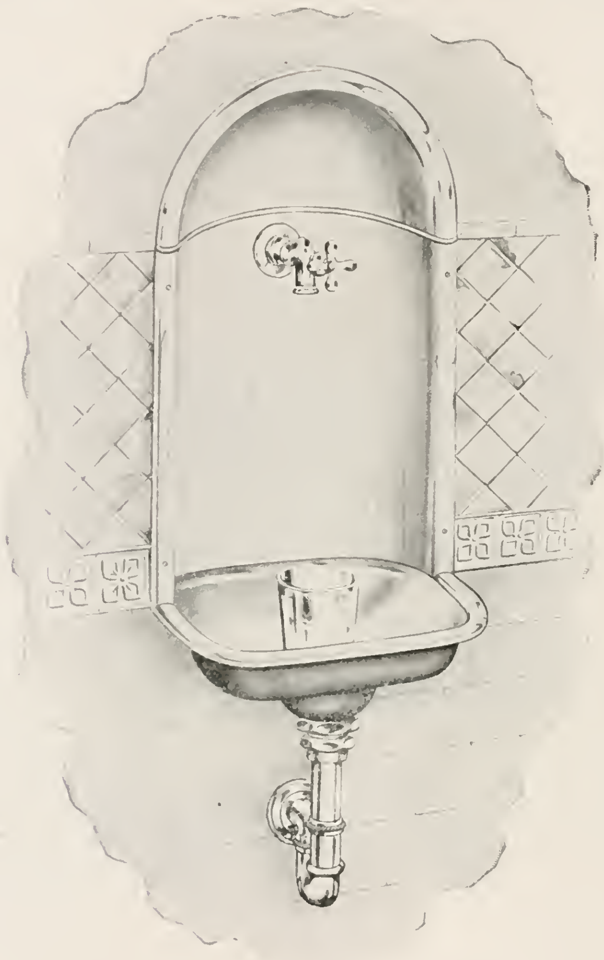


FIG. 142.

for fountains placed directly on the wall (Fig. 143). These fountains are made of porcelain, vitreous ware, enameled iron or marble. The pedestal forms are made in the same materials and vary in design, but are all of the general type shown in Fig. 144. These fountains are equipped with a cold water faucet from the refrigerator supply and a waste and S trap as shown. The faucets should always be of the self-closing pattern. The supply should have a return pipe so that the circulation is complete, and so that cold water may be drawn immediately without the neces-

sity of wasting the water which has been standing in the pipe. Each fountain should be connected to this return, as should all other fixtures at which the supply of drinking water is drawn.

LABORATORY FIXTURES.—In the laboratory there should be at least one sink with long wooden drain boards on both ends. It is better to install the sink in the working table in such a position that it will be handy. The supplies can be brought up at the rear, or better at the side, if the table is accessible from both sides as

FIG. 143.

it should be. The filtered hot and cold water, as well as the house supply hot and cold water, should be brought to this fixture. The sink should be of enameled iron or vitreous ware and never of porcelain, as the enameled iron or vitreous ware sinks are not affected by acids or stains, while the porcelain is subject to staining by acids and dyes.

In the laboratory there should also be placed a slop hopper, into which can be emptied the contents of specimen jars, and such other materials as are ordinarily used in the laboratory. Such solutions should never be emptied into the sink, as they will quickly corrode the waste and trap, which are made of lead or brass,

while the traps for the slop hoppers are part of the fixture. In the hoppers the large body of water quickly and positively carries away the solutions on account of the long, copious flush. The waste pipe from the hopper is of cast iron and is not subject to corrosion as easily as are pipes of other materials.

In the laboratory there should be a small sink supplied with distilled water for experimental and testing purposes. The water may come from a small individual distilling plant, as for the operating rooms in smaller hospitals where no large general plant or storage system is supplied, or if the hospital has but one small plant in the operating department, water can be supplied in bot-

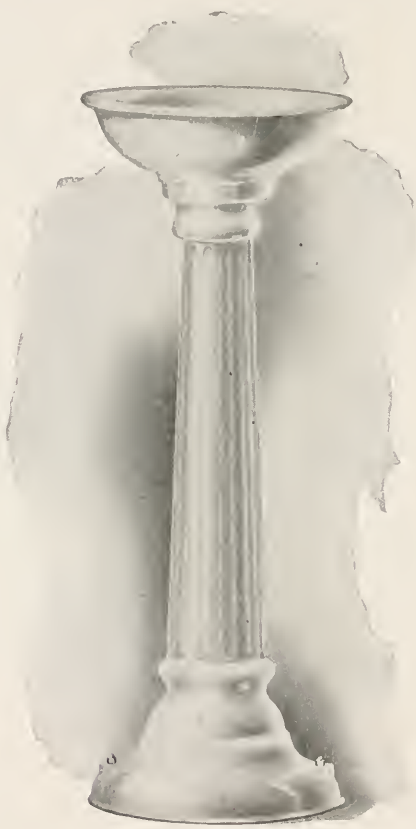


FIG. 144.

tles to the laboratory, as the work would probably not be of such scope and magnitude as to require a great quantity.

Hydro-Therapeutics.—In hydro-therapeutics an apparatus is necessary which is not installed in general hospitals ordinarily. This apparatus consists of control tables, needle and shower baths, bidets, baths, seat baths, shampoo tables, weighing scales and bath stools, as shown in Fig. 145.

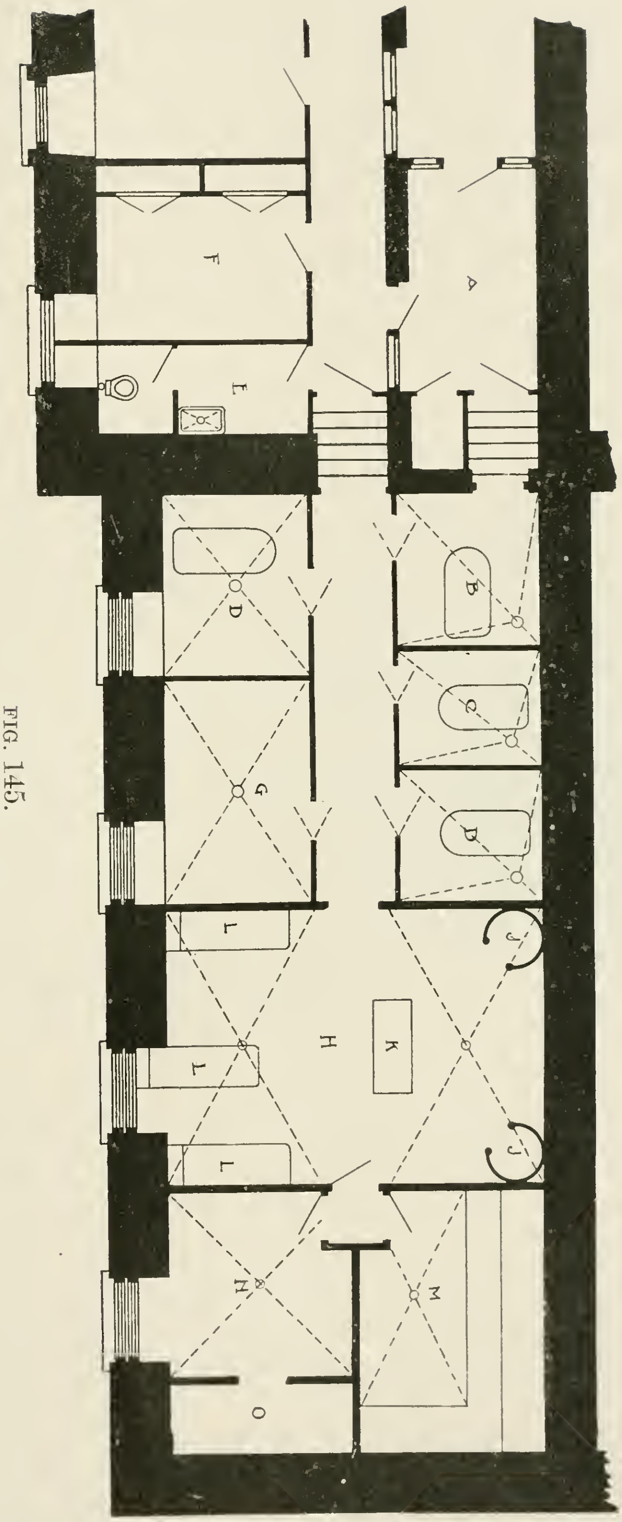


FIG. 145.

A. Emergent room.
B. Emergent bath.
C. Medicated bath.
D. Bath room.
E. Toilet.
F. Dressing room.
G. Sulphur and electric baths.
H. Massage room.
J. Needle spray.
K. Controlling tables.
L. Rubbing slabs.
M. Vapor.
N. Sudatorium.
O. Torridorium.

The Controlling Table is arranged with mixing chambers, each with a temperature-regulating valve, pressure-regulating valve, thermometer gauge and electrical alarm for indicating high temperatures; two special nozzles, with different sized tips for pressure streams. Compression valves are put on to supply hot, cold and ice water to the table, and also to control the water to the various fixtures. The water pressure to these tables must be constant, as also the temperature of the water. To obtain constant pressure it is customary to supply water to the table from a tank or reservoir, located at a sufficient height above the table to give the maximum pressure which will ever be desired for treat-

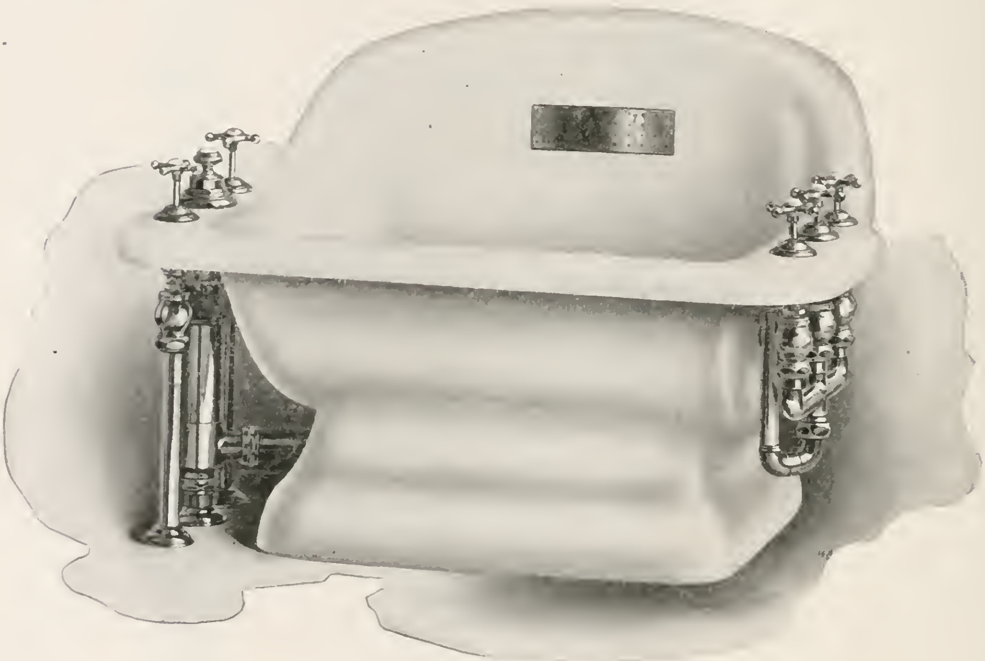


FIG. 146.

ment. Constant temperature may be obtained by the automatic controlling device explained. The pressure controlling device makes it possible to control the pressure from zero to the maximum.

The electrical alarm is attached to each mixing chamber and consists of a special thermometer with a battery and bell, so arranged that when the temperature of the water rises to a point near scalding, the bell rings automatically, thus giving warning to the operator.

Needle and Shower Baths.—These are arranged with four uprights, upon each of which is placed a number of rose sprays, the upper one adjustable, and also a large head spray on a ball and socket joint, so that it can be moved in all directions.

Bidet.—This is a small nozzle, swing jointed, which is usually attached to the shower or to a water closet arranged for this.

Bath Tubs.—This fixture is the same as for ordinary tubs and should stand free as described.

Seat Bath.—This fixture should be set in conjunction with the floor, as shown in Fig. 146, and can be of enameled iron or porcelain. The fixtures should be wasted as described for ordinary bath tubs.

Shampoo Tables.—These tables are made of enameled iron, marble, glass and also of porcelain, mounted on wrought iron standards or frames which are enameled. Over this table is placed a shampoo spray, which, if it is not controlled from the controlling table, should be equipped with a non-scalding device or valve.

Bath Stool.—This is made of wood covered with celluloid enamel with an opening in the center, to be used in connection with the perineal douche.

Resume.—In conclusion, the entire system of sewerage, supply and installation of fixtures should be generous in size and simple in installation and operation. All pipes in supplies should be generously valved, each valve marked by brass tags, giving the location of fixtures on each main and each branch, or should have a numbered tag and a chart conveniently placed. There should be uniformity in all piping, so that corresponding pipes have the same relative location. All risers should have besides the valves mentioned a check valve, so as to avoid back pressure, and in cross connection should have gate and check put on. Each supply at each fixture should also be properly valved, so that any supply at any fixture may be closed off without interfering with any other supply. In this manner the whole system, any part of the system, any set of fixtures, any fixture, or any supply on such a fixture can be closed, and the water turned off without interference with any other part of the system or fixture respectively. Directness and simplicity of system are the first essentials in plumbing requirements.

GAS FITTING.

Gas.—Gas in hospitals is installed for two purposes—illumination and fuel. Under illumination the methods for lighting by gas are fully explained.

Piping.—The method of piping the building depends wholly upon the construction of the hospital. In ordinary construction the pipes are laid over the rough floor, before the deafening is put in, and are also placed in the partitions. In fireproof construction

the pipes are laid in slots left for them, or more frequently are laid on the tile or concrete, and the deafening put in over them if wooden floors are laid, or bedded in the cement, when such floors are finished in materials other than wood. In the latter case the cinder concrete must not be permitted to come in contact with the pipes, as the latter frequently disintegrate when in contact with this material. All pipes laid in floors deafened with cinders must be protected, before the deafening is applied, by a coating of neat cement.

From the meters to all outlets the piping should be properly proportioned so that the system is positive and noiseless. As in water supplies, it is best to run pipes from manifolds, or to take the supply for each floor from a main riser which is placed in the pipe and wire way provided. The system in mains and branches must be proportioned so that there will be no diminution in any lights when other lights, or all lights on a floor, are turned on. There should be a shut-off at a point outside the meter, and also one on each floor for the entire floor, so that the gas on any floor may be turned off without interfering with the lights on any other floor.

Supply.—The tap for gas from the street main into the building is usually put in by the municipality or the local company supplying the gas, and carried into the building where the meter is placed. From the meter the main riser or manifold is taken and from this the several branches are derived. The running of these branches depends wholly upon the location of fixtures and the number of lights on each fixture.

Size of Piping.—In hospitals the minimum size of gas mains and branches is calculated on the number of outlets, the length of the tubing, and the inside diameter of the latter.

MANUFACTURED GAS FOR LIGHT.

Size of tubing.	Greatest length allowed.	Greatest number of ½ inch openings.
½ inch	20 feet	1 opening
¾ inch	60 feet	8 openings
1 inch	70 feet	12 openings
1¼ inch	100 feet	20 openings
1½ inch	150 feet	35 openings
2 inch	200 feet	50 openings

FIG. 147.

BUILDING SERVICES.

Size of opening.	Greatest length allowed.	Greatest number of ¾ inch openings allowed.
1 inch	70 feet	1 opening
1¼ inch	100 feet	3 openings
1½ inch	150 feet	5 openings
2 inch	200 feet	8 openings

FIG. 148.

All openings in service should be equal to the size of the riser, which in no case must be less than three-quarters inch.

MANUFACTURED GAS FOR FUEL.

Size of tubing.	Greatest length allowed.	Greatest number of ¾ inch openings allowed.
¾ inch	50 feet	1-¾-in. or 2-½-in.
1 inch	70 feet	2 or 1-¾-in. and 2-½-in.
1¼ inch	100 feet	4 or 2-¾-in. and 4-½-in.
1½ inch	150 feet	7 or 4-¾-in. and 6-½-in.
2 inch	200 feet	15 or 8-¾-in. and 14-½-in.

FIG. 149.

NATURAL GAS FOR FUEL.

Classification of appliances.	Size of openings. Inches.	Greatest length. Feet.
Small portable gas cooking stove	½	20
Kitchen boiler heater when separated from range...	½	20
Miscellaneous appliances consuming less than 15 cu. ft. per hour each	½	20
Gas cooking ranges	¾	30
Ordinary coal ranges, equipped for the use of gas....	¾	30
Miscellaneous appliances consuming 15 to 40 cu. ft. of gas per hour each..........................	¾	30
Miscellaneous appliances consuming 40 to 75 cu. ft. of gas per hour	1	60

PIPES.—Pipes for gas should be of wrought iron with all fittings under two inches of malleable iron, connections between pipes being made by couplings, the pipes being screwed into these.

All connections between pipes and fittings should be made by screwing together with linseed oil. The openings should all be capped with iron caps, screwed on, and the whole system tested by air pressure.

TESTS.—In testing a pump is used, and the pipes forced full of air to sustain a mercury column at least six inches high. This column is in a graduated glass gauge, and must remain stationary for at least twenty-four hours. This test should be applied before any pipes are concealed either by plastering or before floors are laid over the pipes. The caps should be left on until the fixtures are hung. No split pipes or joints made with cement or lead should be put into the building. The piping should be laid with a fall toward the meter or the main riser, as the case may be, and should be well secured with hooks and bends.

NIPPLES.—The nipples should be of the exact length for hanging the fixtures to them without alteration, as any cutting on account of excessive length, or the placing of additional nipples might cause disturbance of the pipes sufficient to produce a leak in the walls or floors. These nipples should be exactly perpendicular to the ceiling, or at right angles in all directions to the walls from which they project.

FUEL GAS.—Fuel gas should be run separately from illuminating gas, and should be entirely independent of the latter. It should have its own meter and stop cocks. Fuel gas is run in the same manner as illuminating gas, the size of the pipe depending upon the requirements as given in the tables. The piping should be done in the same manner as for illuminating gas, either from a manifold or from a main riser, and the supply on each floor should be independent of the supply for all other floors, with a shutoff on each respectively.

OUTLETS.—The piping should be run direct for the main kitchen, baking room, special diet kitchen, and for sterilizing apparatus. Besides the cock for shutting off the supply to the burners of such fixtures, there should be a stop cock on the supply pipe to shut off the gas from the entire fixture, and one to shut off the gas from each group of fixtures. Diet kitchens should be equipped with fuel gas for stoves and also with a cock for hose connection for a Bunsen flame burner.

The number of outlets and their location in the pathological laboratory depend upon the extent of this department and its equipment. Pipes for Bunsen burners should run exposed at the rear edge of work benches with a sufficient number of taps. Each run should be controlled by a separate shutoff, as well as each individual burner plug. There should also be a general shutoff

for the entire laboratory so that the supply of gas can be turned off from this room without interference with any other part of the hospital. Provision should also be made in this room for the supplying of special apparatus with sufficient burners for this portion of the equipment. There should be several swing fixtures arranged for blow-pipe work.

The placing of separate shutoffs on each group, and on each run and fixture of such groups throughout the building cannot be too strongly advocated. A slight leak in a pipe under such circumstances does not necessitate the shutting off of the entire gas supply in the building, as is the case when these cocks are omitted and repairs are necessary. Moreover, one part of a group can be shut off in any room without interfering with the remainder of the work in that room. This is especially true of hospitals which are entirely dependent on gas for illumination and for fuel.

CHAPTER XV.

PLASTERING.

There are more methods in the lathing and plastering of buildings than there are systems of building, because there is the possibility of applying the methods in many forms. As an example, in non-fireproof buildings ordinary wooden lath and plaster can be used, or the wood lath and cement plaster can be put on. Wire lath and plaster, or expanded metal and plaster, are used in buildings so constructed. There are methods in which plaster board is used and merely a finishing coat put on this. Built up hollow blocks are sometimes used instead of studs and lath, and these plastered with a skim and finishing coat.

In fireproof buildings plastering of partitions depends upon their method of erection. As mentioned in Fireproofing, there are a multitude of these, and the plastering would depend upon

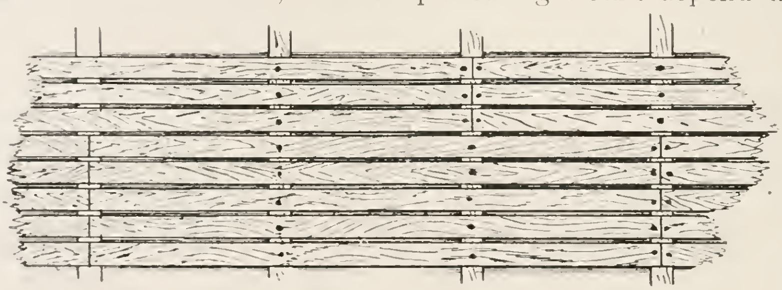


FIG. 150.

the form of construction. In fireproof buildings the inside of outside walls, as well as inside brick walls, can be done in several ways. It is evident, therefore, that to describe all would not be expedient. Such as are ordinarily used will be considered, and the general outline for the plastering will be given to cover all possible and ordinary cases.

LATHING.—In non-fireproof buildings this can be done with wood, wire or expanded metal put directly on the studs and ceiling joists. The following points are to be observed:

If wood lath are used, the best seasoned and sound first quality pine lath should be procured, one-quarter inch thick having no bark on them. They should be placed a full quarter inch apart and be nailed four times in the length of the lath, as shown in Fig. 150. At a distance of eighteen inches over all the areas lathed

joints should be broken, as shown in Fig. 151. There must be no long vertical joints, nor must lath be put on vertically nor run through angles behind partitions from one room to another. The lathing in each room must be independent.

Expanded Metal.—In lathing with expanded metal on wood studs care must be taken that the lath is placed so that the mortar will key properly. There is a top and bottom to this material which is recognizable by the fact that the key should form as shown in Fig. 152. Fig. 153 shows the method of putting this on wooden studs.

Metal Lath.—Metal lath on metal studs are hung over the "clips" on the channel irons, as shown in Fig. 154, and the clips are bent back to securely hold the lath in place. This is the best form of construction of the methods described. It is rigid, inde-

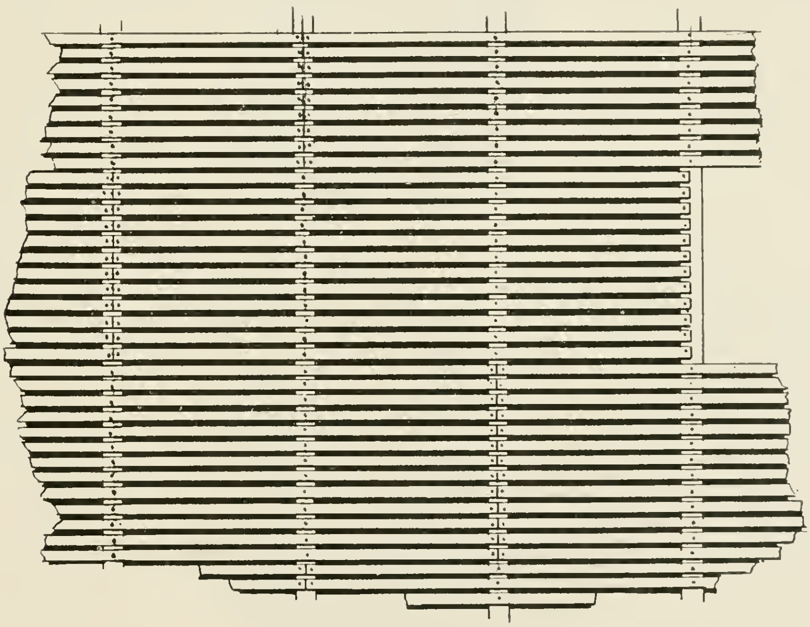


FIG. 151.

structible and absolutely fireproof, besides being practically a unit for each partition when complete.

Tile Partitions.—When tile partitions are put into buildings and the inside of outside walls and inside brick walls have been furred, the following is the method recommended. Where two-coat work is specified, three-coat work can be used, but with hard and cement plasters it has been found that the two-coat work will fulfill all requirements. All slots, iron beams and other iron work where exposed, and all splays where these are formed, except in brick walls, are to be covered with expanded metal lath. Wherever there is a corner, a corner bead should be placed se-

curely, as shown in Figs. 44 to 48, 50 and 51. These beads should also be put on at all other corners which protrude (Figs. 155, 156, 157).

FIG. 152.

PLASTERING.—In making mortar for plastering, it is absolutely essential that the ingredients be given time to thoroughly mix.

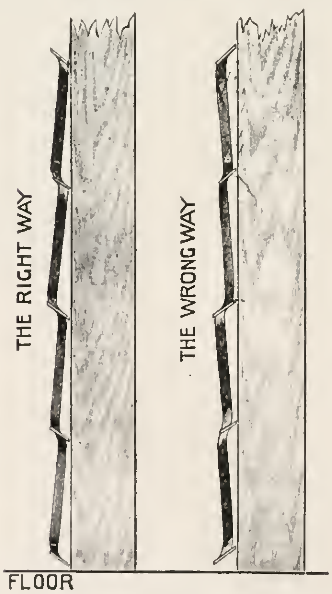


FIG. 153.

The brown coat, or, as it is sometimes designated, the brown mortar hair coat, is made of fresh quick lime, coarse, sharp sand free from loam, and for each barrel of the lime a bushel of good,

sound plastering hair should be used. The lime must be well slacked. This must be done thoroughly, for it is this that makes the difference between good and bad plaster. Plaster which has

FIG. 154.

the lime improperly tempered, pops, cracks, scales and develops all the evils to which plaster is subject. After the lime is slacked

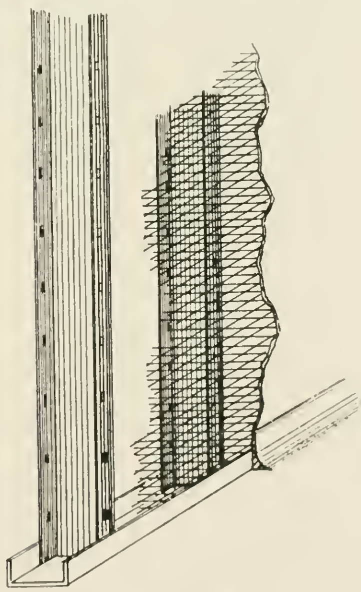


FIG. 154A.

it should be screened to remove any foreign matter. The sand and hair should then be added, mixed, and the whole mass left to stand for at least ten days before being used.

Hard Plaster.—When the ready mixed, hard-wall plasters and cement plasters are used, instead of the ordinary mortar plaster, all that is needed is the addition of water to these in the mortar box and their application to the surfaces. At times a plaster of Paris putty is mixed into these to prevent too rapid setting, as all of these so-called patent plasters dry out much quicker than common plaster. They are somewhat more expensive in first cost, but are far superior, if of good quality, to the best mortar plaster. They finish with an extremely hard surface, and the bond between the coats is as much a chemical as a mechanical "clinch," if they are put on in the proper manner. The

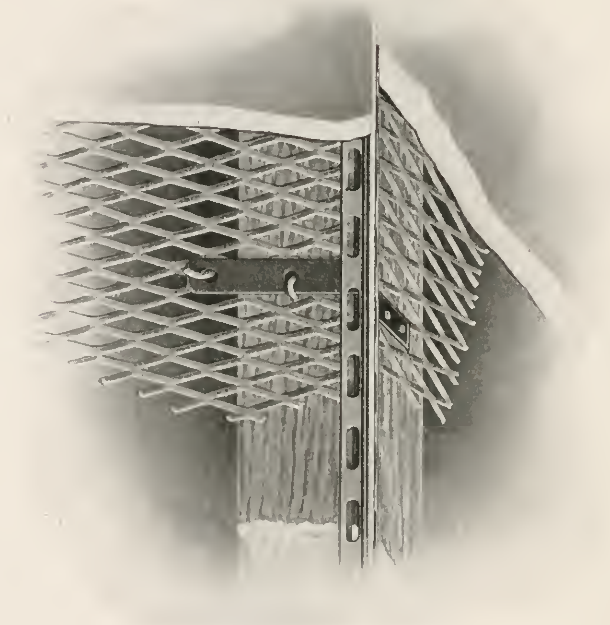


FIG. 155.

saving of time alone more than compensates for their little advance cost, and in wear and tear of the material they are a good investment. Decorations are not subject to stains in them as in lime mortars when such staining is due to the plaster.

Plastering is done in one-coat, two-coat and three-coat work:

One-Coat Work.—In dumb-waiter shafts, pent houses, walls and ceilings of basement, except where there is no plastering necessary, one heavy coat of hard plaster should be applied, and this troweled down perfectly plumb, straight and smooth.

Two-Coat Work.—Two-coat work is applied to all walls, partitions and ceilings, except where one and three-coat work are put on. The first coat, known as the brown coat, is put on and

troweled down perfectly plumb and straight, and before this is set, or hardens, it is scratched with a piece of wire mesh; over this is put the finishing coat. Care must be taken that the brown coat is wet before the latter is applied. The finishing coat is put on and carefully gauged—that is, made level and true throughout its length and height on walls and level on ceilings. This is troweled down to a smooth, glossy surface with a trowel and brush, care being taken that no brush marks show. All angles should be sharp and true, plumb and straight, as the case may be.

If lime mortar is used, a finishing coat is put on made of stucco and lime, the former being made of plaster of Paris in pro-

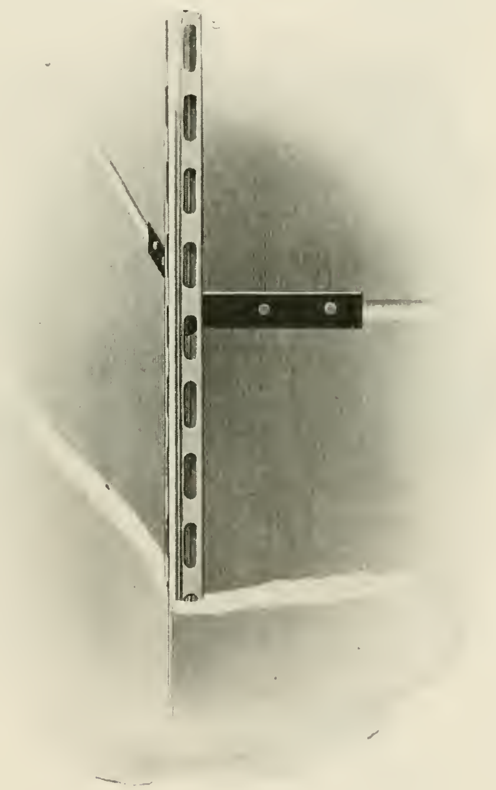


FIG. 156.

portions to secure a good and well-finished wall. This coat should be well gauged and brought to a smooth and glossy surface, showing no brush marks. When using lime mortar for plastering every precaution should be taken to prevent stains through insufficient tempering. This may be done by mixing into the putty coat, or white hard coat finish, a fixed quantity of chemicals made for this purpose. This has also the tendency to give a higher degree of hardness to the white finish when it is dry than it would otherwise have.

Three-Coat Work.—Three-coat work should be done on all

surfaces lathed with expanded metal lath. The first coat is designated as "scratch" coat. It is a rough coat, heavily scratched,

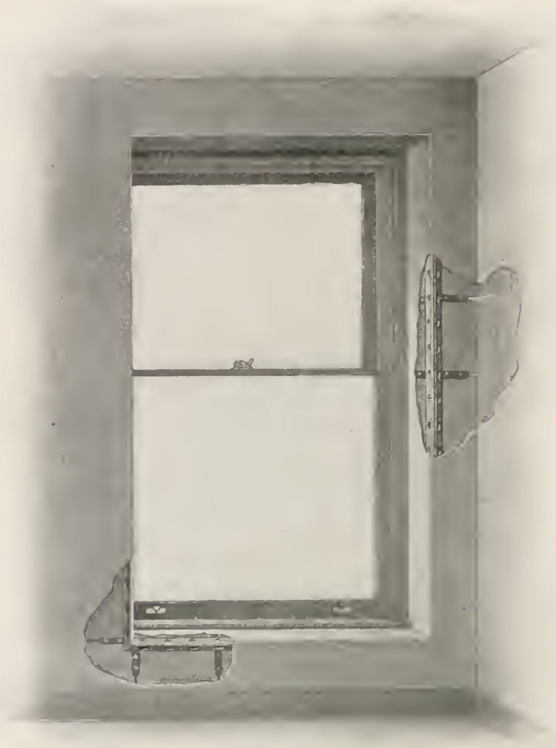


FIG. 157.

and serves the purpose of forming the "keys" which hold the plaster to the metal (Fig. 158). Over this is placed a browning coat, as described, and then finished with the finishing coat.

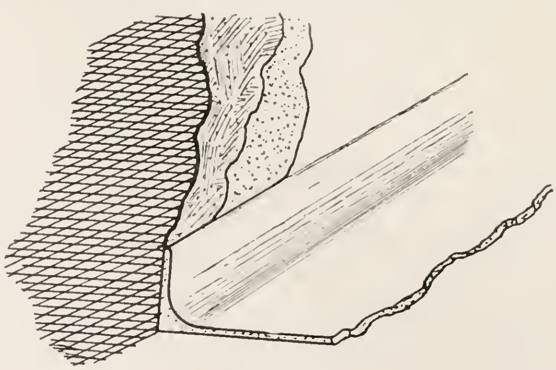


FIG. 158.

OPENINGS.—All openings for ventilating registers and thimbles for pipes should be carefully considered and the plastering brought to these in a neat manner. This also applies where the

plaster runs to molds to form splays, sills and jambs (Figs. 47 and 51). Where no trim is to be used and corners are rounded, this should be done carefully so as to get true surfaces plumb and straight. If coves are formed at the ceiling these should be "run"

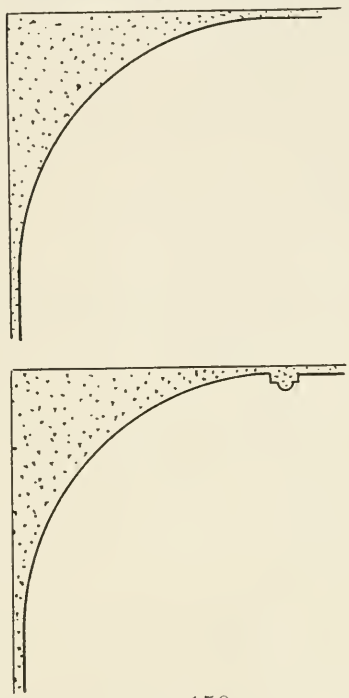


FIG. 159.

in forms, made of metal, and should be gauged—namely, made true on their entire length with trowels shaped for this purpose. Coves are ordinarily run solid, as shown in Fig. 159, but they can be formed by expanded metal, as shown in Fig. 160. While coves at the ceiling may be considered as an ornamental feature, they are not a necessity, for the accumulation of dust in the angle formed by a wall and the ceiling is slight. Where pressure systems of ventilation are used, coves might be advantageous, but even under these circumstances they can be omitted. They are expensive luxuries at best.

It might be mentioned here that when hard plaster is used a very successful and inexpensive floor cove can be formed when the wall plaster is put on, as shown in Fig. 161. In doing this, it will be necessary to put down either a metal or wood ground which is permanent, so that the cove is not broken when the floor is laid.

Covers.—It is often necessary, and a good precaution at all times, to have the window openings in the entire building covered with canvas or cheesecloth to exclude dust and dirt, and to prevent cracking of the plaster on account of air currents. The windows

should never be tightly closed with glass, if possible, for the plaster dries too slowly, except in freezing weather, if all air is ex-

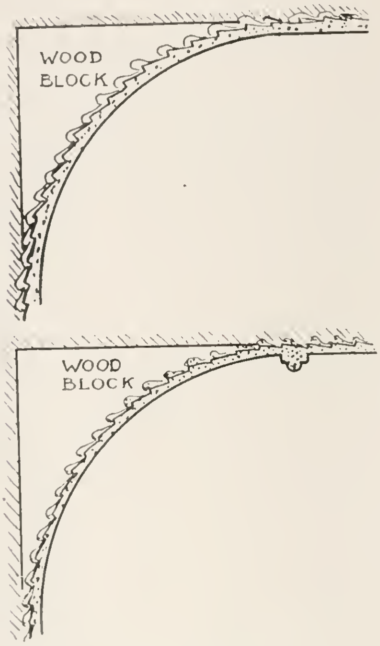


FIG. 160.

cluded. In freezing weather this precaution is necessary, but the windows should be left partly open top and bottom, so as to expe-

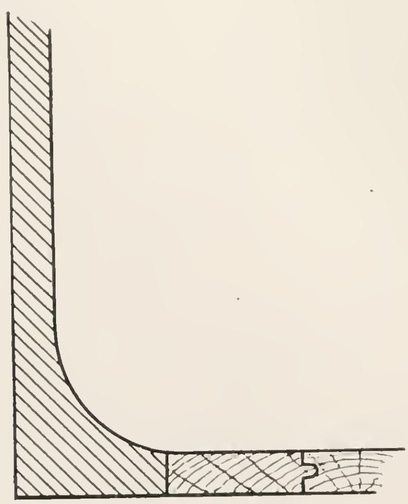


FIG. 161.

dite the evaporation of the moisture in the plaster. Too quick drying is to be avoided, as it causes checks and cracks.

CHAPTER XVI.

PAINTING.

There is no part in the construction of hospitals which permits of such latitude of treatment as the interior painting and decorating, especially where it would seem that a recognized standard should be followed. At first glance there seems little need to give the subject much scrutiny, but this is not the case. Precedent, moreover, is not necessarily a standard, for this has often been the guide for the improper treatment of walls and woodwork. Because white enamel, for example, is good material to use in operating rooms, it does not follow that it is the best, nor even the proper, material to use in other parts of the building. Especially is this true of closets, for reasons which will be given later.

Under the heading of paints, enamels and varnishes will be given an analysis of what constitutes good material, their proper application, the best methods to be employed, and the place in which each is to be used to the best advantage.

Paints.—In general the use of paints for walls and interior decoration is constantly growing. These are much cleaner and more healthful than wallpaper or tinting. They dry with an egg-shell finish, in light and pleasing shades, and can be very harmoniously arranged. They can be cleaned at any time with little trouble with warm water and soap and rubbed with a flannel cloth.

In finishing walls in these interior colors, the best manner of procedure is to give the walls one coat of best quality ready-mixed paints, and after this is thoroughly dry put on a coat of "size." This latter is pure boiled linseed oil equally reduced with turpentine. The turpentine is used to thin the oil so that the plaster will absorb it. Upon this base is put one or two coats of paint, according to the finish desired. The last coat should be stippled. This is done with a stippling brush, and consists in going over lightly the last coat before it is dry, by striking the bristles of the brush against the surface upon which the paint has been applied.

The object in putting the "size" between the coats is that should any object hit the wall, instead of the white plaster show-

ing and making unsightly spots, it would chip off the coats over, and the under coat would remain and still show the same color as the paint, it being on the plaster itself underneath the size.

Attention is directed under plastering to the special treatment of plaster walls. It will be necessary in many instances to treat the walls in the manner described to prevent stains on the paint, the lime in the mortar not being sufficiently tempered, on account of its use too soon after mixing. When the plaster is not sufficiently tempered it attacks the lead in the paint. It is often necessary when this occurs to scrape the entire surface of the walls and ceiling, and remove both paint and much of the hard coat of plaster, and then to treat such scraped surfaces with compounds. In some instances it is even necessary to put canvas on after the plaster is scraped smoothly. This canvas is then painted.

Undue haste should not be permitted here, for it is the cause of more expense and worry than the matter of a few days' delay really warrants. As stated in the chapter on Plastering, no work of this character should be done until the lime is perfectly tempered. In some instances in which good work has been required, plaster has been mixed fully a year in advance of its use, merely to overcome any subsequent delays, and the possibility of ruining decorations. While this is not necessary under ordinary conditions, it is an indication that care bestowed at the outset prevents direful consequences which inevitably follow undue haste.

Enamels.—There are many so-called enamels on the market that extreme caution must be exercised in the choice of these, and also in their application. Particular attention is directed to materials of this character which retain their elasticity. No enamel which contains lead should be used, as it deteriorates quickly, turns yellow and cracks. Only such are safe to use as are absolutely guaranteed not to crack and which hold their whiteness or color indefinitely. It is well to look thoroughly into this subject, as it is the means of saving time and money and the annoyance of refinishing.

In finishing plaster walls with enamel no special preparation of such work is necessary, for materials of this kind can now be obtained which are guaranteed to withstand all staining from plaster, if the enamel is applied after the plaster is thoroughly dry. This last precaution is absolutely requisite, however, for the successful treatment of walls and ceilings in this manner. Enamel, above all other material, is recommended for the treatment of surfaces to be decorated. Such surfaces are easily cleaned and absolutely sanitary, and the enamel is easily applied. The application is as follows:

New Walls.—In enameling new or unpainted plaster walls four coats should be used. The first coat to be lead and oil, about one quart of boiled linseed oil to the gallon, the remainder to be pure turpentine. The second coat should be a perfectly flat coat—namely, lead and turpentine, with only the minimum of oil, not over half a pint to the gallon. The third and fourth coats should be good flowing coats of enamel as taken from the can. The third coat must stand 24 to 36 hours before the fourth is applied.

Plaster Walls or Woodwork Previously Painted.—The old paint should be thoroughly cleaned, and, if white, washed down with strong soda and warm water. The first coat should be a perfectly flat one of lead and oil—namely, lead and turpentine, with only the minimum of oil, not over half a pint to the gallon. The second coat should be a good flowing one of enamel taken from the can.

Interior Woodwork of Close Grained Wood.—All woodwork should be thoroughly sand papered with fine sand paper. All knots should be shellaced to prevent the sap from coming out. This is called "killing." The first coat on the wood should be lead and oil, with about one quart of boiled linseed oil to the gallon, the remainder to be pure turpentine. The second coat should be a perfectly flat one of filler or lead and turpentine, with only the minimum of oil, not over half a pint to the gallon. This should then be rubbed down with fine sand paper to remove any prominent brush marks. The third coat should be a good flowing coat of enamel as taken from the can. After the third coat has stood for 24 or 36 hours, it should be rubbed down with sand paper, or pumice and water, just enough to cut the gloss, and then a fourth coat of enamel applied.

Open Grained Woodwork.—A good hardwood filler should be well rubbed into the surface; after this is dry and hard the work should be sand papered lightly, and a thin coat of shellac applied. The first coat over this is the usual lead and oil, the same as for other work. The other three coats to be applied the same as for close grained wood.

Many so-called enamels contain a large percentage of lead, which inevitably oxidizes under the action of lime, antiseptic fluids and general atmospheric conditions, thus not only causing discoloration, but cracking and scaling.

Enamel, no matter what shade is used, even if it be pure white, will turn darker in color if put into closets and other dark places. The action of light on these, as well as on paints, is to cause them to retain their color.

When we refer to enamel our minds immediately conceive

white. This, however, is not the limitation of color, for the range is without limit from white to black. All shades of grays, blues, greens, reds, yellows, and, in fact, the same multiplicity of shades as in paints, are obtainable in enamels. There are primarily two classes of these—the flat and gloss. By the mixture of these in the same shade, or even different shades, any desired gloss can be obtained, the result being quite artistic.

Varnish.—Another source of annoyance in hospitals, as well as in other buildings, is the deterioration of the varnish. Cracks and checks appear, the varnish turns white or blisters or "sweats." This latter is due, however, to improper application oftener than to inferiority of material. It causes the unsightly spots which look like oil stains and which are so evident in their discoloration. When a coat of varnish is applied before the preceding coat is thoroughly dry, the result is usually this "sweating."

For the best and most desirable results where varnish finish is desired on the woodwork, the use of three coats of varnish is recommended. The first coat applied directly to the wood, thinned by about ten per cent of pure turpentine. This should be sand papered smooth after it is thoroughly dry and hard, and followed with two coats of regular body varnish without thinning. As stated, sufficient time must be allowed between the coats to permit each to harden thoroughly. Liquid fillers and shellac should never be put on the wood under varnish, as it does not make a durable job. These cause the varnish to easily scuff off, or the varnish turns white on the filler and shellac. This is especially true of window sills and woodwork exposed to the weather. If the metal-clad trim were used throughout, as mentioned in the chapter on Carpentry, this method would not apply, as such trim is painted and grained to look like wood, and is then varnished in the same manner as in woodwork.

Floors, where of wood (and it is evident that these are never to be of open grained wood, but preferably of maple, which is close grained), should be given a coat of floor varnish thinned by about ten per cent. pure turpentine. They are then sand papered smooth and given two good coats of varnish. The same objection to the use of shellac and filler, as stated in connection with trim, applies to floors also, with the addition that the varnish, besides scuffing off, shows heel marks when applied over these.

Taken in the order in which they are mentioned herein, the treatment of rooms and surfaces with these materials respectively is as follows:

Paint and enamel, being interchangeable, as may seem best

to those in charge—although enamel is recommended—no separate mention need be made for general conditions.

The walls and ceilings of wards and rooms, corridors, offices, consultation and waiting rooms, and such administration rooms as exist, should be treated as stated, in colors to suit the rooms in which they are used, if such a standard can be established, or to suit the taste of those who have this in charge. Enamels in rooms and wards are undoubtedly to be preferred—those of the flat variety being the best, as there is no reflection of light which is so trying on the eyes of the patients. White is not a good treatment, for the reason that it gives a cold appearance to the room or ward. Soft gray or buff and delicate green tones for the walls of wards are admirable. For the corridors these colors also may be used, but the ivory and buff tones are much to be preferred, as they are warm in effect and make the corridors bright and cheerful. The rooms and corridors of upper rooms where there is plenty of light can be somewhat darker in tone, white enamel being added on each floor from the top down as the light diminishes, until on the ground floor the enamel is several shades lighter than that above. The walls can be treated in one color and the ceilings in another, or the walls in a darker tone, and the ceilings in light tones of the same color.

No gloss enamels should be used except in operating, sterilizing, toilet, bath, dressing and anesthetizing rooms. Kitchen and diet kitchens should also be treated in gloss finish. These should be done in white gloss, including the woodwork. Varnish can be used on the trim, but it is not as good as the enamel, as the latter is more elastic and is not affected by antiseptic solutions. Flat enamels soil much more easily than gloss enamels, but by mixing these a slight gloss can be obtained. However, the soiling of walls is of no great consequence, as the enamel is so easily cleaned, and this must be frequently done for hygienic reasons. In hospitals ordinarily the occupants of such rooms are not about enough to soil the surfaces.

The question of finishing walls of operating rooms has never been definitely settled. The methods of treating such walls are fully explained elsewhere. It seems, however, after much thought and investigation on the subject of such rooms, that walls, ceiling and trim of any of the various materials named are no better than those which are carefully enameled. Enameled surfaces are as easy to keep clean and are as aseptic and serve their purpose at a much lower cost. They can be renewed yearly with but little expense and are always white and sightly. The enamel never cracks, if it is of the right kind, and retains its whiteness indefi-

nitely. There is only one precaution necessary—the walls must be thoroughly dry before the enamel is applied.

Varnishes should be on all trim and on wooden floors, except in the rooms in which enamel is used as stated above.

In general these conditions should be followed: All woodwork should be clean before finish is applied; all knots and resinous spots where paint is applied to woodwork should be shellaced, using grain alcohol shellac. Wood alcohol should never be used in good work.

Outside Painting.—Three coats of paint should be used on all outside work, including tin, iron and other metal. The first coat of paint on all metal work, however, should be either graphite or one of the mastic paints now in use on bridge work; and which are not affected by fumes. Red lead is extensively used for first coat on metal, but this is not the best manner of treating such surfaces, as it does not protect the metal sufficiently. All nail holes, also all cracks and imperfections, if any occur after the priming or first coat is applied, should be filled with putty.

Inside Painting.—Painting of walls is not ordinarily considered a part of the inside painting, but more properly as part of the decorating, except the enamel work. The same rules hold as for outside painting. The varnished surfaces must have all nail holes puttied with putty, colored to match the wood after the first coat is put on.

Staining.—The matter of staining woods to any desired color must necessarily be left to those in charge. Very artistic and beautiful effects can be obtained in this manner. In the private rooms this could be done to advantage and the furniture finished to match. This, while it may be purely the esthetic viewpoint, might be advanced as an argument in favor of making our hospitals homelike. This would give to the occupants of such rooms surroundings to which they are ordinarily accustomed. It entails no additional cost to do this, and helps considerably in making hospitals more attractive. Wards should be finished in light color, preferably the natural colors of the wood.

Other Methods.—When the walls are finished with hard plaster or cement plaster, they may be treated with a cement coating, a substance resembling calcimine. This material has been successfully used under the above conditions and very pleasing effects obtained at small cost. As a matter of economy in the first instance, and in order to permit the walls to dry out thoroughly, these substances can be used. They are made especially for cement, plaster and stucco surfaces. They are not cold water paints and contain no glue or other substances subject to deterioration,

but are oil paints without white lead, and can be cleaned and washed the same as any lead and oil paint. They do not rub, crack or peel. Their great advantage lies in the fact that they can be applied to a damp surface where it is impossible to make paint and enamel stay. One coat is often sufficient for ordinary purposes. They need not be removed when permanent decoration is done, as they act as a base or filler.

It seems that this might be good practice, inasmuch as it serves a double purpose, and it must be evident that economy at the outset along these lines is to be commended. The drying out of the walls cannot be too well done, and anything which will facilitate this is to be recommended. In many instances the plastering is completed well in advance of the occupancy of the building, so that sufficient time has elapsed for thorough drying. However, in the usual rush of our modern methods this is not always the case, nor is it expedient to have it so. As has been stated, delays are costly, and when the same results can be obtained by a little delay in the final decorating without additional cost, it is the proper course to follow. By drying out of walls is not meant the evaporation of quantities of water into the room, but rather the final setting of the plaster, which is always attended somewhat by very slight moisture.

Calcimine.—The same results would undoubtedly be obtained by using calcimine or cold water paints. They have the disadvantage, however, of having to be renewed frequently, as they cannot be cleaned as can paints and enamels. The ordinary tinting, so called, consists in calcimining the walls and ceilings. This is done by "preparing" the surfaces to be treated with hard oil and over this applying the calcimine.

CHAPTER XVII.

ELECTRIC WORK.

Under the head of Lighting are fully described the different methods of hospital illumination. In this chapter the entire subject is treated from the point of construction, and such devices as are necessary for the several systems will be given only in those forms as will be necessary for their proper installation. The subject of electric wiring for power, illumination and for the many other purposes is too comprehensive to be treated fully in a chapter of this character. There are separate treatises on each and all of these subjects. Power plants, moreover, could not be standardized in their installation, as they depend wholly upon conditions, the results desired and the size of such installations. The installation of the necessary wiring for lighting by electricity, whether it be in the use of incandescent lights or of the other forms of lighting described under Illumination, is primarily the same for all cases. It is only necessary to ascertain the number of lights, the amount of power, whether for running motors or special apparatus, and proportion the feeds, mains and branches accordingly.

Each municipality has its own rules and regulations governing the wiring of buildings, and each local company also has its requirements for such work; added to these is also the National Board of Underwriters' code, which must be complied with, if the rate for insuring the building is to be kept at a minimum.

Systems of Wiring.—There are two systems of wiring a building for electric lighting—viz., the two and three wire system. The mains are usually on the three-wire system if the supply of current is alternating, and the submains on the two-wire system. Branch circuits from either of these are on the two-wire system from distributing cut-outs. Wiring is also done in either bush work—the latter either sealed or open work—and the former run in conduits, which are pipes specially made for this purpose.

The open system need not be explained particularly, as the requirements of the conduit system fully cover it.

There are two methods of running the conduit system—one the laying in of the entire system of piping, and the pulling in of wires from outlet to outlet in branch circuits; or the installation

of pipes already wired, which come in long lengths. The conduit in pipe form comes in various lengths, and is put together with an ordinary screw and nipple, in the same manner as is gas pipe. The objection to conduit systems of this kind is that in bending the pipes from one outlet to another the pipe is flattened at the bends, and makes a difficult passage for the wire to be drawn through. It is recommended that some of the flexible conduits, which are now being manufactured and made water-tight, be used in all this work. They are much more economical in their laying, although their first cost is somewhat in advance of the pipe conduit. They have the advantage, moreover, of coming in great lengths and being continuous from one outlet to another for this

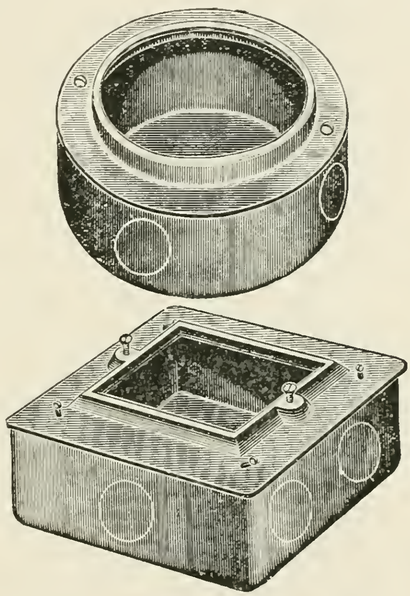


FIG. 162.

reason. At the joints of the pipe conduit, unless these are carefully reamed and smoothed, there are rough places where the wires are liable to catch, and the insulation scraped or "skinned" from the wire, making it possible to short-circuit the entire system by contact of wire and metal.

OUTLET BOXES.—Where difficult bends are required in the system it is best to put in an outlet box, which can afterwards be hermetically sealed, but should be accessible at all times, in case it is necessary to redraw the wire into such conduit for one cause or another.

Fig. 162 shows outlet box. These are made of pressed steel and have dies punched lightly into them on all sides, so that a blow from a hammer will drive them out. The pipe is held in these by means of a lock nut, and a bushing on either side as shown. These are threaded or screwed on the end of the pipe.

Wire.—Main wires within the building, and also submains, are usually cables which are manufactured and which come in unbroken lengths and are run from the source of supply to the cut-out box or distributing panels, as the case may be. The main feed wire, be it from the outside source or private plant, should run to a switch cabinet in which is placed the service switch for the building.

The wire used in the building must be amply designed for the loads which are to be carried, and should be of the best rubber-covered type, thoroughly waterproofed. The mains from the service to the cut-out cabinets should be provided of ample carrying capacity and of such size that the maximum drop in their voltage from the service to the cut-out cabinets should not exceed two per cent. The wire for the distributing circuits, which run from the cut-out cabinets to the various light outlets, should not be less than fourteen-gauge copper wire, and each circuit should have no more than twelve lights. For circuits more than one hundred feet in length the wire should be of sufficient size so that the drop in potential should not exceed two volts at the full load.

The wire for power, such as for elevator service and such other electrically driven power, as laundry machinery, pumps, etc., and for X-ray and other electrical apparatus of like character, will not be specially mentioned, as these must be left entirely to the kind of power which is to be supplied and the number of volts necessary for this power. The usual voltage for such power is far in excess of what is required for electric light.

Joints.—All joints in wire where spliced, or where branches are taken off, and all connections throughout the work should be thoroughly soldered. Wrapping these joints with tape to insulate them, without this soldering, is neither safe nor positive—that is, there might be a flaw in the connection, and a consequent disorder of the entire plant dependent upon the wire. Moreover, it is a point at which an electric spark might, by causing fire, do considerable damage. After the joints are soldered they should be wrapped with rubber tape to the thickness of the insulation of the original wire, and the whole should then be covered with a friction tape extending over the insulation, and on both sides of the joint, to make a firm and secure hold. All wire should be run from outlet to outlet in unbroken lengths—that is, there should be no joints whatever except at the outlet boxes.

Cut-Outs.—Cut-out cabinets should be placed on each of the respective floors which they are to serve. The feed for these cut-

outs should be run in a pipe and wire slot provided for the purpose and ordinarily should be lead protected. The cut-out should be in the same position in each hall or corridor, so that there is a uniformity which makes it possible for quick and easy access, and so that the main feed wire can be run with as few submains as possible. Moreover, these cut-outs should be put in the wall at a convenient height so that they are easily reached. Arrangement should be made for the cut-outs when the building is erected, by leaving areas in the wall, so that the doors which cover these boxes are on a flush surface with the wall, and can be made very sightly as well as convenient.

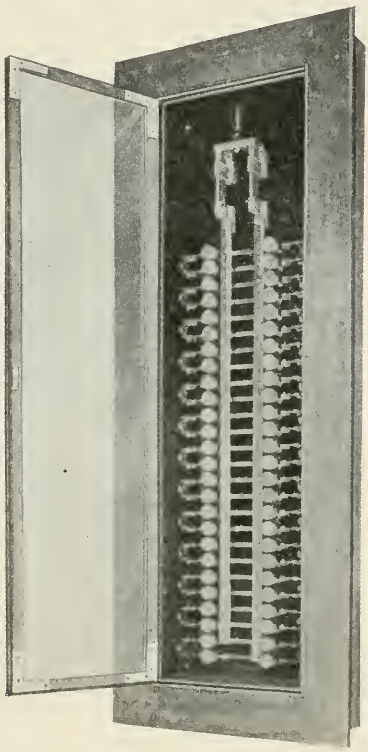


FIG. 163.
Cabinet panel—two-wire mains.

CABINETS.—All cabinets must be designed for the purpose for which they are intended, as there may be more or less variation in the number of cut-outs and switches which are to be put into these cabinets. There are two types of these—the ordinary steel box, which will be explained, and that in which a wiring compartment is used. The former is illustrated in Fig. 163 and the latter in Fig. 164. All these cabinets should be built of one-fourth inch thick steel, their corners dovetailed, substantially reinforced with corner irons, and lined throughout with one-fourth inch slate or

marble. Conduits should terminate in these cabinets similarly to conduit boxes, as shown in Fig. 162, and these should be set in the wall flush, as mentioned, and be provided with suitable mat or trim and door frame. The doors of these cabinets must close against the rabbet or groove so as to be dust tight, and should have a cupboard door catch, and if necessary a lock and key.

Distribution Panels.—These panels are placed at the back of the cabinet and are made of slate or marble and should have suitable main and branch bus bars mounted upon them. These bus bars are the strips of copper shown in the illustration (Figs.

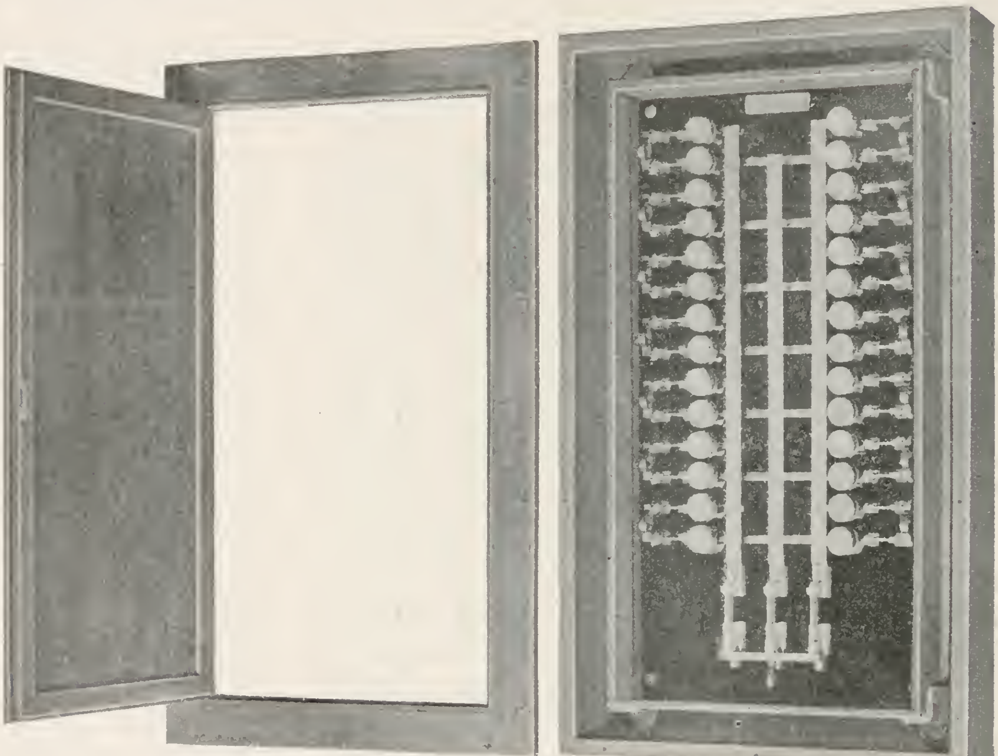


FIG. 164.
Cabinet panel—three-wire mains.

165, 166), and are now used in almost all work of this character. The old method of "skinning" the wire and securing it by clamps at each fuse block is neither safe nor reliable. In the bus bar types, of which there are several, each circuit should be independently controlled by a secondary switch, besides the service switch for the entire floor, so that one circuit can be out of service without disturbing the remainder of the circuits while necessary repairs are being made in the former.

Fuses.—The fuses in these boxes can be of two kinds—the ordinary Edison fuse plug which screws into the receptacle and

shown in Fig. 164, and the inclosed type of fuse plug. In the latter there are spring clips set at proper distances to receive the ferrules which are set on each end of the fuses and connected with the fuse inside the pasteboard casing. These fuses are made in several types, but the principle in all is practically the same, the object being to prevent any arc or electric spark when they burn out. They should be of ample capacity, but should be no heavier than required by the code. The plug fuses are also made of the inclosed type.

The object of all fuses is to prevent fire or accidents if the

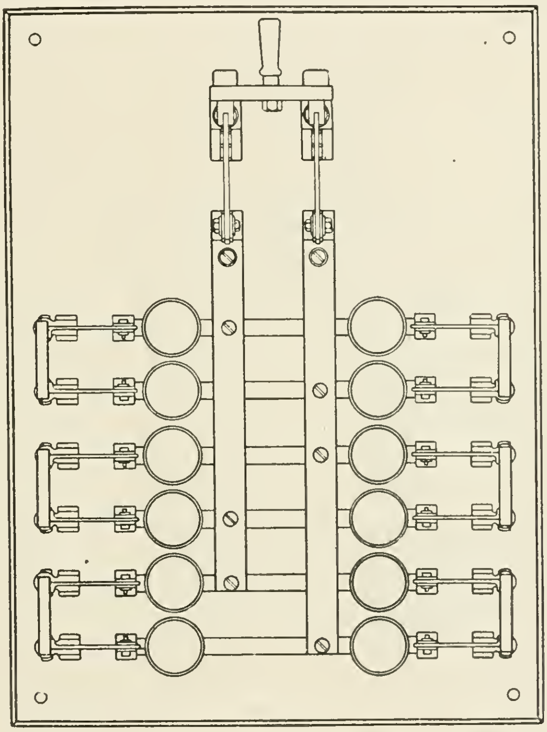


FIG. 165.
Two-wire mains—double-branch circuits, main and circuit switches.

voltage becomes too high in the wires or on the circuits, the fuses being designed to burn out and so shut off the current in the particular circuit in which they are placed. There are necessarily two fuses in each current, one on each wire.

Switches.—Whether the current for power work is from private plant or from outside source, there should be placed on the main feed an automatic circuit breaker of carrying capacity sufficient at all times to automatically control this current (Fig. 167). These circuit breakers are put in where house pumps, elevators, refrigeration machinery and other electric power is used, to protect the apparatus against overloads, short circuits, underloads, reverse currents and unbalancing in three-wire systems. On the main

feed there should be placed a service cut-out. This can be one of many kinds, often a combination of circuit breaker and cut-out, but under all circumstances it should be a well-constructed and positive-working switch. The triple-pole service cut-out, as shown in Figs. 168, 169, is especially for large installations. It is so arranged that when it is closed, with the handle in its normal position, both covers are locked to the box. In case of emergency a half turn of the handle and a strong pull opens the complete cut-out, the blades acting as a triple-pole switch. The main service

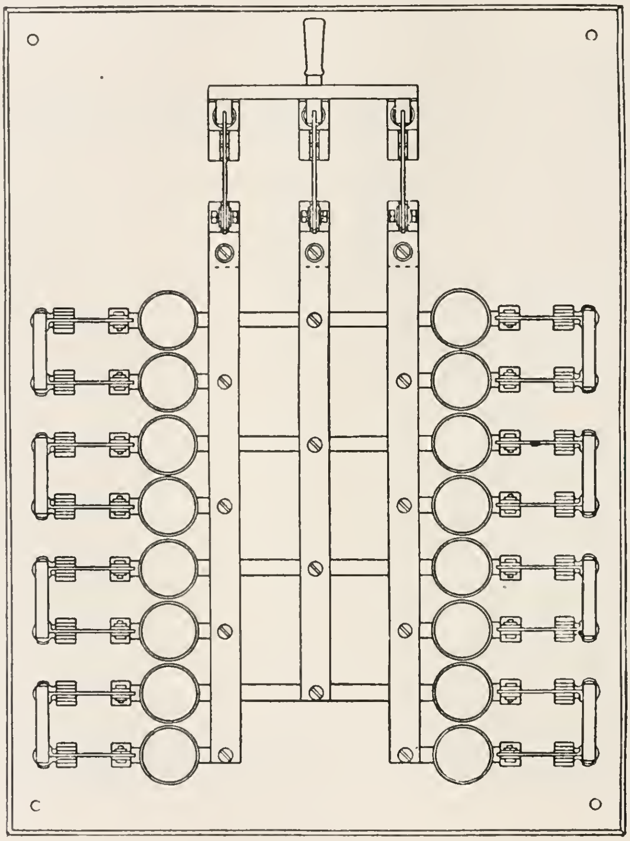


FIG. 166.
Three-wire mains—three-wire double-branch circuits, main and circuit switches.

switch or cut-out should always be placed in an iron box and at an accessible point, so that in case of fire or for other emergencies, it becomes imperative to shut off the current, it can be done readily. If the current is for lighting only a triple-pole knife switch cut-out is installed in a convenient place, as described for circuit breakers, so that the entire current can be shut off in the building in case of necessity. On each floor there should be placed a service switch, so that the entire current on that floor can be cut out without interfering with any other floor. As stated, there should

be a small switch or branch switch on each circuit, so that any circuit could be cut out without interfering with any other. The auxiliary switches and branch switches should all be placed in the same cabinet, as shown in the illustrations.

All chandelier outlets and all lights at the ceiling should be controlled by separate switches, either of the snap or turn pattern, or of the double push button type. Fig. 170 shows the snap switch, and Fig. 171 shows the push button type. For vapor lighting it will be necessary to provide knife switches. The switches controlling lights should be selected with a view to their durability and wearing qualities, as well as to their perfection in working.

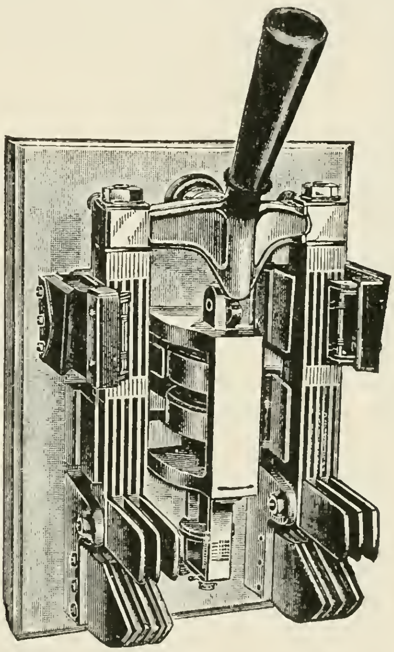


FIG. 167.

There are many so-called electric switches to be obtained which fail to operate when most needed. All snap and push button switches should be set in steel boxes which are made especially for the purpose (Fig. 172). This is done for two reasons—as a protection for the switch, and because these switch boxes are put into the walls and partitions before the walls are plastered. It is only necessary when these boxes are installed to put the switches into place and fasten them to the lugs made for the purpose after the switches are properly connected. This does away with the driving of wooden plugs, which are very insecure, and in some instances difficult to put into place. The boxes should be set plumb and straight, and in such manner that the mat plate over the switch sets closely against the wall.

In closets where there are lights, and there should be such lights in all closets, two kinds of switches can be used—the jamb switch, which turns out the light when the door is closed, and the snap switch with an "off and on" indicator (Fig. 173). The latter should also be used throughout such working parts of the hospital when the lights which are switch controlled are not in sight when

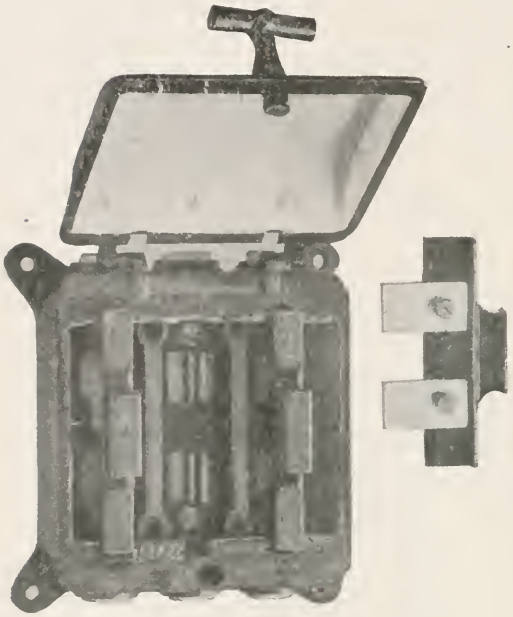


FIG. 168.

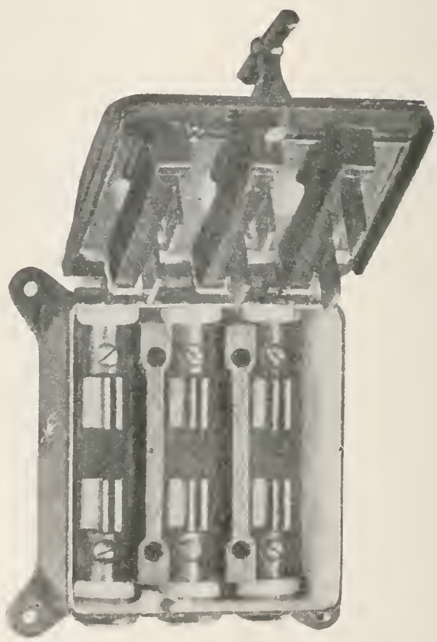


FIG. 169.

the switch is turned—namely, in ice boxes, linen and locker rooms, where the switch is usually placed outside the room. In closets, drop cords, with key sockets, are also used, and in some instances this method has its advantages.

Plugs.—Plugs for the attachment of portable lights or for connecting apparatus should be generously distributed. There should be a flush receptacle plug at the head of each bed throughout the rooms and wards. These should be uniform so that any

lamps in the hospital can be brought into and used in any room or ward. Under Illumination the objects of such lamps are fully explained. These plugs would also serve for the new electric warming bags. Receptacles for plugs either of the flush type or of the type to receive sockets should be provided for X-ray apparatus at

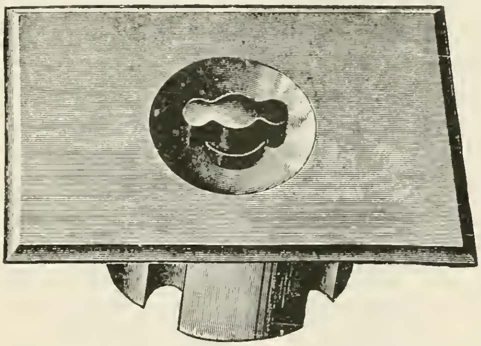


FIG. 170.

fixed points, as also in the X-ray room. In the latter, however, special panel boards are usually installed. In the diet kitchens there should also be plug receptacles with as many circuits for each as will be found necessary for any cooking or heating apparatus,

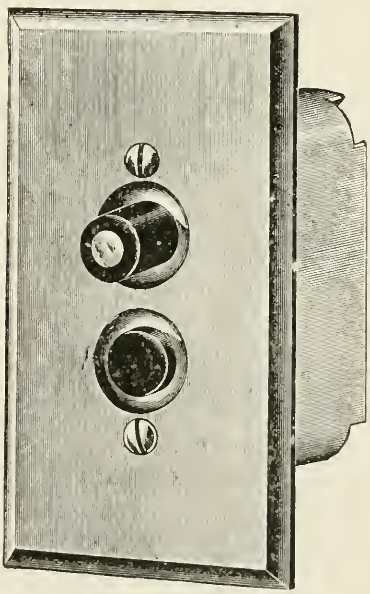


FIG. 171.

although at the present time cooking by electricity is somewhat more expensive than any other form. Its cleanliness, rapidity and ease of handling, as well as absence of odor, are so evident that it no doubt will eventually, to some extent, replace other forms of heat for cooking purposes in hospitals.

Plugs in rooms can also be used during the summer months, when the temperature is high, for connecting electric fans of the small household type. At some given point on each floor the plugs for X-ray apparatus should be so placed as to give access easily to rooms where such treatment is necessary. The plugs in the diet kitchen could also be used for this purpose. In the oper-

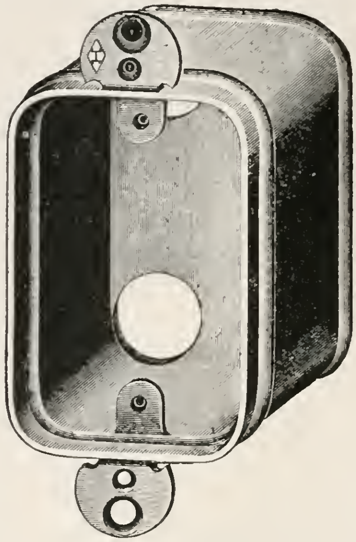


FIG. 172.

ating rooms there should be plugs for such apparatus as is electrically used, such as galvano-cautery and apparatus for exploratory work.

LIGHTS.—The wiring to all outlets should be done to flush outlet boxes, so adapted that the fixtures can be supported from

FIG. 173.

them. In operating rooms, if swing brackets are used, the outlet should be on the wall in such position that the connection can be made as it would be for an ordinary wall bracket.

Circuits should be so arranged that lights on them are not

scattered—namely, that the twelve lights on any circuit should not supply corridors and sundry rooms, but should be concentrated as closely as possible. Corridor lights should be run, if possible, on alternate circuits, so that if one circuit supplying the corridor is inoperative for some reason, alternate lights will still be burning in such corridors. What is required, if possible, is an independent outside supply for such corridors, so that in case all lights went out on the regular supply, the corridor lights would still be in service, and so facilitate the travel of the nurses from room to room to light the gas.

Signal Systems.—Systems for signaling from rooms and wards are of two kinds—the annunciator with bell and drop or needle indicator, and the more modern electric signal system. The latter is rapidly replacing the former, owing to the annoyance of ringing bells, and the ease with which the annunciator gets out of order and its lack of positiveness in working. There is another system, a combination of annunciator and electric systems, but

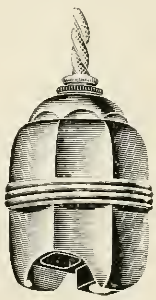


FIG. 174.

there is the same objection to this as to the annunciator with bells and batteries. It consists of an inclosed switch worked by battery, which closes an electric circuit, and so indicates by light, as does the electric system. The necessity for a battery switch makes the connection indirect, and so is subject to the same constructional faults as the annunciator system.

The electric signal system is both direct and positive, as only the current of electricity, which is used for lighting purposes, is necessary, and there is no other apparatus needed except a push or pendant switch and a relay for the pilot lamp. It is also noiseless. This system is as follows: At the head of each bed is installed a flush plug receptacle or flush outlet for a flexible cord. This receptacle is placed above the floor cove, and a flexible electric light cord is run out from it, upon which is placed a pendant push (Fig. 174). The two-button protected push is superior to the one-button push or to the push with one button to close the circuit and a small release button to open the circuit. Except the

two-button switch, these all break when they fall from the bed to the floor, as they frequently do. These pushes when operated light an electric light at the door jamb or over the door. This light should be red, as the white light during daytime is not readily seen, and at night the flashing would disturb other patients by

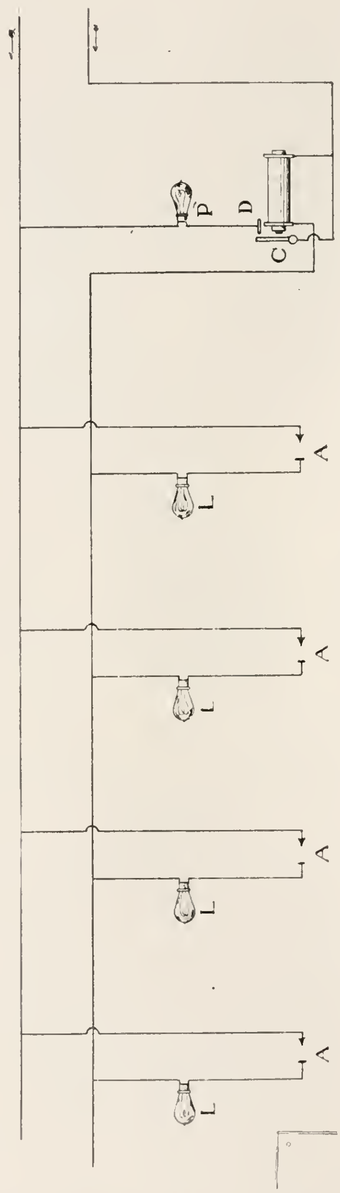


FIG. 175.

reflection through transoms. When the button is pushed to turn on the light at the door, a light called the pilot is turned on in the diet kitchen or nurses' room. This latter light is operated through a primary coil, as shown in the Fig. 175. This light, which

is placed in the nurses' room, does not go out until all the signal lights on the floor are out. Another pilot light for each floor can be placed in the superintendent of nurse's room, so as to check each floor at all times. These pilots in the head nurse's room would be placed on a board and indicated with the floor number. The floor nurse or other nurse can only put out the door light by going into the room and turning off the current at the pendant push, and the pilot light will not cease burning until all door lights on the floor have been extinguished. For wards, an auxiliary relay or primary coil could be put in so that all patients who called from one room would have to be given attention, and the current turned off from all buttons pressed before the door light would be extinguished. Such a system should be separate for each floor and be independent of all other lights. Fig. 175 shows the wiring of such a system, and also the primary coil. The pilot light must be put into the circuit before all other lights. When a light at a door is turned on by pushing the switch "A," the current magnetizes "B" as it is passing through the light at "L." This magnet draws up the lever "C," which forms a contact with "D," and in this manner closes the circuit to the pilot light "P." As long as a light is in operation anywhere on the floor the primary coil is magnetized and the lever "C" is in contact with "D." As soon as all lights are out there can be no more current flowing through the wires, the coil no longer is magnetized, the spring in the lever releases it from "D," and the pilot is extinguished.

Another system which has been used successfully to some extent is designed for low voltage signaling. It has as its greatest advantage the simplicity of its installation. It is only necessary in this system to install the wiring that would be used for the ordinary annunciator system. It consists of an armature and a magnet so arranged that when the circuit is closed it is locked, and both the signal and pilot lights will remain burning until a reset push button is pressed by the nurse. The signal button is an ordinary pear-shaped bell push on a flexible cord, which is of sufficient length to be brought to the bed. The reset button is a push on the wall beside the bed at a convenient height. This reset is so made that into it can be plugged the locking attachment. This locking attachment is the part of the apparatus which closes the circuit and turns on the signal and pilot lights. The object of plugging the locking attachment into the release is to facilitate the quick removal of the former if it does not work properly for any reason, and putting another in its place without the delay of repairing and the inconvenience of doing this at the bedside. All that is necessary is to have on hand a few extra attachments.

In this system where there is more than one button in a room, as in wards, it is necessary for the nurse to release all of the buttons in that ward which had been pushed before the signal light is extinguished, and all of the lights on the entire floor must be out before the pilot is extinguished.

The entire system is run on batteries of a closed circuit type, or of the storage type, and will operate on from four to ten volts. It would be advisable, however, to use a motor generator instead of batteries, and while this is running through the day it could be storing a set of batteries to which the entire system could be switched at night, and the generator shut down.

The signal lamps on this system are the ordinary miniature lamps. In the nurses' room is placed an annunciator with signal lamps or targets indicating the room or ward from which the call is sent. An auxiliary annunciator could be placed in the Superintendent's office showing all the rooms and wards in the hospital as described above. If the hospital is built on other than the straightaway plan—namely, those of U-shaped plan, in which there are cross corridors—there can be more than one station for nurses, and in such a case there would be an annunciator in each nurse's room. Both of these annunciators would be so arranged that by the turning of a switch the entire signal system could be switched to one board or the other, so that all of the patients could be taken care of from one station when the calls are but few, as at night. The objection to this is the same as in the ordinary annunciator system—namely, that the more or less delicate and intricate apparatus is liable to get out of order.

Bells.—The number of bells and their location depend wholly upon the wishes of the authorities, and no rules can be set down for this part of the electric work. Under any circumstance there should be a push at the main entrance, connecting with a bell in the nearest room, which is used day and night. This would probably be the diet kitchen nearest to same. Another bell connected to the front door push, and ringing at the same time as the main bell, should be placed in the matron's or the Superintendent's room, or in both, with a small cut-out switch on each. The bells should be of good make with platinum points, and should have a sharp, full ring, but they should be of such a size that the ringing does not disturb patients in the hospital, as all such bells are used more frequently at night when the doors of the hospital are locked than during the day.

Batteries.—Batteries for these bells need no special mention, as they can be of the sal-ammoniac type or other wet cell type, or the dry cell type. The latter is possibly the better to use, as it

needs no attention except replacing by new cells when the old ones run down, the cost of these being very small. The open or wet cell needs renewing of water, adding of sal-ammoniac, and replacing of the zinc electrode. In the use of the dry cells, in case of gradual weakening, the stronger cells will reinforce the weaker until they are all run down, when they must be replaced by an entirely new set. All wire for electric bells and battery work should be rubber covered.

Telephones.—Instead of the old method of speaking tubes, or even the electric bell signal, modern hospitals are now equipped with intercommunicating telephones. These often take the form of extensions, with switchboard of the outside telephone. This has many advantages, but a private telephone system serves the purpose as well, and if the latter can be made to connect to the outside or public telephone, it has all the advantages of the extension system. In the private telephone system the entire apparatus is the property of the hospital, and can be controlled by it, whereas in the public telephone system restrictions are made which are often onerous.

Telephone systems of the extension type need not be explained. Those of the private type are known as the central energy intercommunicating telephone system, and are so arranged that all currents for signaling and for transmission are furnished from the main battery. Each station in this system should be so equipped as to enable connection to be made from any station to any other station without the possibility of interference from another instrument, and which will permit two or more stations to operate at one time without interference with each other. The instruments here are of the automatic switch and plug type, operated on two general plans—one is to install a switchboard at some central point, at which all the telephone lines terminate, and by means of which an operator can connect any two lines together for conversation. Intercommunicating systems of this type should be used where there are more than twenty stations. For twenty stations or less intercommunicating phones of the individual push or individual switch or plug type should be used. In these the person making the call does so by pushing a designated button or placing a plug or switch on the proper point for the call desired. In the selection of such a system, and the instruments therefor, too much stress cannot be laid upon the necessity of using only those which are of approved and tested merit. There are systems designated merely to meet first cost requirements, yet which will cost more than a good system in repairs alone. The subject of transmission of orders in a hospital is far too important to permit it

to rest on the expenditure of a few dollars more or less, as the difference in cost between the best and those which have no merit except low cost is surprisingly small.

Telephone systems should be equipped with a superintendent's call button, which is a button on the main office telephone, which rings all the telephones on the system simultaneously. This is put on so that the physicians or other attendants can be called to the telephone by a designated number of rings on the floor, or at any part of the buildings at which they may be at any time.

Wiring for Telephones.—All wiring for telephones, whether large or small installations, should be done in metal conduits terminating in steel outlet boxes. The boxes should be so set and of such type that the wall telephones can be fastened to them. The wire should be in cable form, and be run in unbroken lengths from outlet box to outlet box where telephones are to be placed, and should be not less than eighteen-gauge copper, rubber-covered for battery wire, and triple braid weatherproof for the remaining lines. All wires exposed to moisture should be run in conduit in lead-covered cables.

Batteries.—The batteries depend wholly upon the extent of the telephone system, but under no circumstances should the battery for signaling be used for the battery for talking. They must be independent and of a capacity for the proper operation of the system.

The location of telephones is wholly dependent also upon the extent of the installation and the general plan of the hospital. In the office and superintendent's room there should be desk instruments. For the diet kitchens, main kitchens, engine or boiler room, and operating department, telephones of the wall type are more adaptable. If the system consists of over twenty phones, the switchboard should be conveniently located in the office or at a point where one of the working force of the institution can readily answer all calls. In very large installations a switchboard operator will be necessary.

Power.—Wiring and apparatus for power depend wholly upon the extent of such installations. In hospitals it is not recommended to run line shaftings, as these at best are not as quiet in operation as the individual motor. Each piece of equipment and each elevator or pump should be run by an individual motor, either direct connected, which is the preferable form, or geared or belted. This individual drive has the great advantage of economy, as the motor is only operated, and the power used, when the individual piece of apparatus to which it is attached is in operation. In the system where one motor and line shaftings are used,

it is necessary to operate the motor at all times, and in this manner the consumption of current is a maximum, whether all apparatus is in operation or whether only the smallest unit is in operation. Installations must be figured for each particular case, as no standard can be given, but should have a good percentage of excess power so as to be quiet and positive in operation.

CHAPTER XVIII.

VENTILATION AND HEATING.

VENTILATION.

In treating this subject only such methods are mentioned as will fully explain the most effective systems. No ventilating work can be complete without specific knowledge of the principles involved; what ventilating means, what its objects are and how these may be obtained.

Both the Heating and Ventilating sections are given as fully as possible in a chapter of this character, but are not intended to fill the requirements of specific cases. These must be left to the expert. We are indebted for much valuable information to Mr. S. Homer Woodbridge, of Boston, whose exhaustive study in this line is well known.

In discussing the relation of air to vital energy, we are plainly dealing with one of the most important of the basal truths of man's relation to, and dependence on, the sources of energy which are placed for his appropriation and use in the carbon of food and in the oxygen of air.

The fundamental truth or law on which the demand for ventilation is based is this: Though Nature's resources and operations are vast, her methods and requirements are neither coarse nor haphazard nor approximate, but exact; precise to the extreme. The air as it exists in the open is perfectly and exactly adapted to man's vitality and to his industry. Increase the proportion of oxygen, and his vitality exhausts itself in its intensity. Decrease the proportion of oxygen, and vitality droops, languishing in the dullness of its unsupported fires.

The air as it is, and exactly as it is, in the open, is meant also for vegetation, as vegetation by nature is created and sustained.

Abundance and, therefore, purity of air is of more importance to the boiler furnace than is quality of fuel. With a poor draft the most successful and faithful fireman can do little, even with the best of coal. With a good draft he can make and keep a hot fire with poor coal. So also for vital fires purity of air is more essential than is purity of food. The one is created and provided

without human instrumentality; and environed in it man continuously lives, and of it he as continuously breathes.

Food, made or provided through human instrumentality, is partaken of only at intervals. However viewed, as to origin, as to continuance of use, as to importance of purity, air ranks above food in vital importance.

Ventilating work, when intelligently planned and faithfully performed, takes due cognizance of the foregoing fundamental truths and principles; and of the laws of nature on which that work must be based if it is to be correct in application and effective in results. It regards the hospital as the retreat of vitality depleted through the shock of accident or the waste of disease, and, therefore, the place of all others where the physical condition of the subject demands the fullest purity of vitalizing air. Furthermore, the time of duration of exposure to conditions maintained in the hospital is long, compared with that of exposure to the air of theaters, lecture or music halls, or churches, public conveyances, land or sea. Temporarily, for longer or shorter periods, the hospital is as continuously occupied as is the dwelling house, and more so than the office or school building. The two considerations, therefore, of the state of susceptibility of body and also of the time of duration of exposure, conspire in the demand for a more free ventilation of hospitals than of any other class of buildings for human occupation.

In surgical wards are those reduced by the shock of operation, augmented, it may be, by that of accident. In the air may float pus microbes. In these instances is enfeebled vitality on the one hand, but less danger in the quality of the contents of the air on the other. Floating dust is less microbic, or the microbic form is less dangerous in character in the general than in a contagious ward. The air supply may, therefore, be reasonably reduced from the quantity appropriate to the contagious wards.

The physical condition in the general, or medical wards, is marked by vitality depression and the atmospheric condition by an absence of moribific quality. A lower per capita air-supply is, therefore, admissible than for either the contagious or surgical wards.

What shall, or perhaps we may more safely ask, what should be the gauge of air supply to these several parts of the hospital?

No air can be too pure for the need and use of the great virile vitality, certainly not for impaired vitality. If atmospheric impurity is to be maintained at a minimum, then atmospheric quantity must be maintained at a maximum.

If gain to health were proportional to air supply, a use of the

largest possible supply might properly be urged, as also an unlimited spaciousness of rooms which would permit of the use of fair quantities without drafts.

Somewhere the minimum and the maximum limits for air must be placed. The hospital is not a fitting subject to invite a discussion of such minimum. Of all places, the hospital is the place for maximums in all that can increase air. Everywhere, but most of all in the hospital, the rule of ventilation should be "the maximum admissible, rather than the minimum tolerable."

The cost of warming air for ventilating purposes where coal can be had at $5 per ton, and where the outside climate during the closed season averages 35 degrees F. below the indoor temperature, and where fuel is not badly wasted in fires, is 20 cents for each 1,000,000 cubic feet of air used, equivalent to a per capita supply of 4,000 cubic feet an hour for ten days of 24 hours each, or, roughly, two cents a day for 1,000,000 cubic feet of pure air!

What supply, then, shall be given to those sick with infectious diseases, to restore vitality, to dilute and remove the moribific contents of air, to protect those uninoculated with the disease? A maximum of 8,000 cubic feet per hour for each bed is surely a rational demand. And what for the surgical ward? Surely a per capita supply of 6,000 cubic feet an hour is a moderate maximum. For the medical ward, and for average cases, that limit may be fixed at 4,000 cubic feet an hour for each bed, as a maximum.

Passing from general principles to some of the more specific methods to be followed in the ventilation of hospitals, the first suggestion relates to the importance of so ventilating some parts of the hospital as to protect others than the patients occupying them, or, in other words, the use of such a method of ventilation in particular cases as shall prevent the escape of air from the affected rooms to other rooms, or to corridors connecting with such rooms. Such ventilation, to be effective, must isolate that room, atmospherically, from its surroundings. To accomplish such a result its provided discharge ventilation must be in excess of its provided supply ventilation. Rooms requiring such so-called "vacuum ventilation" are contagious wards, private or general, sanitary, operating, mortuary, etherizing and bath rooms, kitchen quarters, lockers and lavatory rooms. The major force operating to ventilate these rooms should be on the side of discharge rather than on that of supply. The air of corridors and adjacent rooms would then tend to move toward and into the vacuum ventilated rooms, rather than from such rooms into surrounding quarters.

The means required to accomplish these results are a proper size of exhaust or discharge flues, and sufficient strength and sure-

ness of draft in them. Such means are easily obtainable by a proper area of flue, height of flue and heat in flue, or by a suitable fan power connected with the exhaust part of the ventilating system.

The second suggestion is that other sections of the hospital should have a greater strength of ventilating work on the supply rather than on the discharge side. Such ventilation should be furnished to all wards, private or general, for other cases than infectious, and for all living, administrative and work quarters, other than those named as more properly ventilated by a predominance in vacuum action.

By maintaining a condition of lower atmospheric pressure in those parts of the hospital which should be atmospherically isolated, and by maintaining at the same time a higher pressure in those parts which should be protected, the trend of air movement is made to set from the quarters in which the air should be maintained at its purest, toward and into those in which, from one cause and another, the contained air must of necessity, and may without harm, be more or less contaminated by impurities which vary from the dangerous to the offensive and to the relatively innocent.

The third suggestion is that what should be done in the manner described for the hospital as a whole should also be done for special quarters. There is, for instance, no adequate justification for allowing the offensive odors attending excremental discharges to escape from water closet seats, and to diffuse through rooms for dilution in air previous to its breathing, nor for the heat, steam, smoke and fumes from a range to fill the entire kitchen before any attempt is made to remove them. Here, again, the drift of air movement should be toward the vitiated locality, so strongly, surely and continuously that the offenses shall be confined to the place of their origin, and removed without so much as a chance of mixing with air the purity of which should be maintained for breathing.

The general law governing these matters and applicable to all ventilating work, and designed to insure effectiveness and economy in that work, is that of limitation and removal by saturation, as against diffusion and removal by dilution. Ten cubic feet of air a minute moving toward, into, through and out from a water closet seat will more effectively protect the room against excremental offenses than ten or twenty times that quantity of air passed through the room itself—just as the throat of a fireplace moving one hundred feet of air and smoke a minute from the fire burning on the hearth will keep the room free from tear-making

smoke as 1,000 cubic feet per minute would not, and could not, if the same fire burned on an open hearth, as in the olden time, in the center of the room.

METHOD OF VENTILATION.

There is one method of ventilation among the many which, when admissible, is incomparably the best in simplicity, efficiency and economy. The method is the wind, and the means the windows. In the quantity of air moved and in the effectiveness of ventilating work, human ingenuity and enginery cannot approach the results obtained by perflation.

Artificial ventilation can, at the best, be only a substitute for such natural ventilation. Artificial ventilation is necessarily no more, nor no better, than a substitute for that which is natural and perfect. No forcing of air through provided ways and ramifying flues by spanking it with paddle-fan blades, or putting it through the screws of the propeller-fan, or torturing it with hot irons of steam heaters can make it do all it stands waiting to do if given the adequate opportunity for its own work in its own way.

The insuperable obstacle to the universal and continuous use of the natural or open-window and door method is in the nature of outdoor climate during the portion of the year when artificial ventilation must be resorted to. Only in the equatorial zone and adjacent territory is free and abundant ventilation by Nature's methods possible during the entire year. In the temperate and colder zones artificial warmth must be maintained in buildings for occupancy during fully one-half, or more, of the year. Outside cold must be excluded, and as air in its natural condition cannot be admitted without also admitting cold, a limitation must be placed upon the air supply, and therefore upon ventilation. That fact, however, does not wholly preclude a use of the natural method, even in the cold northern winter season. What cannot be continuously used with safety may be temporarily used with profit. Wards, living rooms, dining rooms, almost all quarters of the hospital may be advantageously flushed with an in-flow, through-flow and out-flow of the purest, most invigorating and least "doctored and manipulated" air obtainable. For the purpose of making such a method of ventilation usable and useful to the maximum, architects could provide for it by furnishing transom windows, which, when opened, will throw the entering air upward and reduce floor drafts to a minimum. Such transoms should be furnished with checks for preventing a lateral inflow of air and for insuring an upward flow only. The air currents will then expend their draft force near the ceiling, the entering cool

air will mingle with the warm air of the upper room before descending to the floor; drafts will be reduced, and inflowing air will be tempered before the breather is reached. The benefits of such a method of ventilation are important and large, provided the inflow of air is free and that harmful drafts and chilling effects are eliminated.

Continuous ventilation of the same type, but much more limited in degree, may be had by filling the opened sash spaces of windows with a cloth of open mesh, such as the finer grades of cheesecloth. The cloth may be stretched on frames similar to, or identical with, those of fly-screen frames. For mild cold weather a single thickness of such cloth may answer, and for colder weather one thickness of the cloth on each side of the frames. This method requires a surface cloth corresponding to the rate of air-flow, or of its diffusion through the cloth between the inside and outside air. A square yard to each breather is a

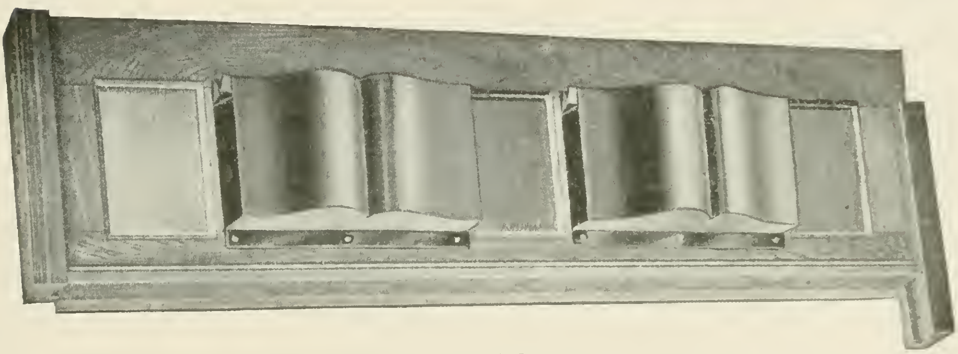


FIG. 176.
Panel to be inserted under raised sash.

fair amount of surface, if the outside air is quiet, and if the conditions within are not such as to make the inward movement of air too rapid for its proper warming. The action in the case of the double stretch of cloth is partially one of warming, since the in-moving air, which is cold, meets and diffuses with the outgoing air, which is warm, the latter imparting a considerable part of its heat to the cold and inward moving air.

The method has been found applicable to and advantageous in the sick room of private residences, and it may be easily and profitably applied to the wards and other rooms of hospitals which are without incorporated systems of ventilation.

A more modern method, however, than the one suggested above is the insertion into the windows, either in panel form as shown on Figs. 176, 177, or making provision in the lower sash for one of the several forms of so-called natural ventilators, which are here illustrated. Figs. 178, 179, 180, 181 show two forms of

these ventilators, the first having an automatic device for the control of air by means of a swinging shutter; the second acting in the same manner as the first without the shutter, and in consequence avoiding the rattle which might occur in the former. Figs. 177, 182 show a form of ventilator which can be put in the lower sash of the window, and also in the upper sash if necessary, and is particularly adaptable to natural ventilation in hospitals. Fig.

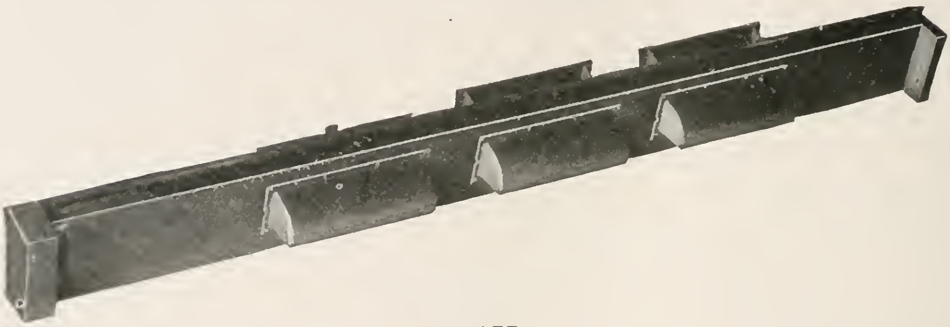


FIG. 177.
Panel form of 8 in. oblong ventilator.

183 shows another form of ventilator in which the air supply can be regulated to some extent, but in this form it is necessary to open the window and leave it so sufficiently to admit of the putting in of the ventilator. Fig. 184 shows one of these ventilators put into the masonry work of the building, preferably in panels under the window; they are both efficient and sightly in this form. The

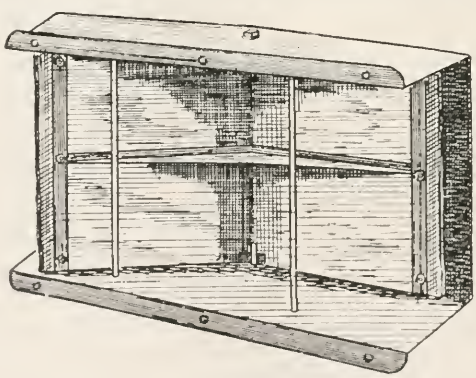


FIG. 178.
Inside of exterior hood, showing swinging shutter.

advantage of so placing these ventilators is obvious, inasmuch as the air entering could be brought directly in contact with the heating surface of the radiator, and the chill taken off in this manner.

As is stated below, the inlets for the air should be between beds, if possible. In all forms of natural ventilation it will, of course, be necessary to have some outlet for the air in the room in

order to create the circulation necessary for ventilation. In general hospitals doors should be provided with transoms, as stated elsewhere, and the corridor could thus be made a large and voluminous vent-duct, which would be more than sufficient for all ordinary needs, so far as the quantity of air to be conducted is

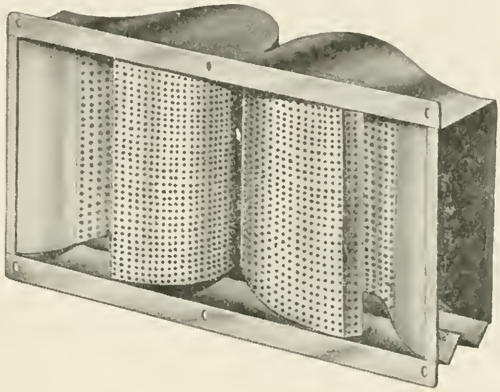


FIG. 179.
Inside of exterior hood square ventilator.

concerned. If this is done, however, it will be necessary to place at the opening of each corridor some adequate means for carrying off the air, which would come into the corridors through the transoms from the rooms. This can be accomplished in several ways —namely, the creating of a slight draft by means of a radiator placed below the windows, and the use of some form of screen

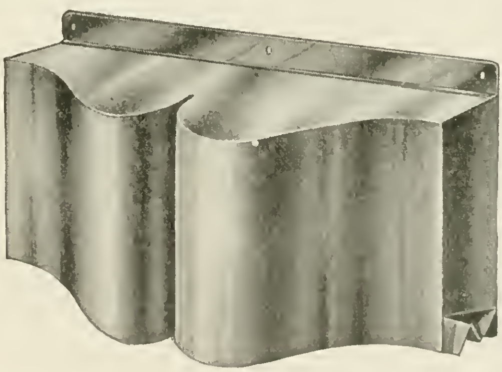


FIG. 180.
Outside of exterior hood square ventilator.

work, or a number of ventilators, at the top of the window. This will also serve the double purpose of keeping the air in such corridors somewhat purer, and at the same time keeping them at a temperature such as will be required.

The same object can be accomplished by the building of ducts through the wall above the window. This would create a through draft in the corridor and would also act in the same manner as

described for the ventilators, the entire action being enhanced by the warm air from the radiators beneath the windows, rising and

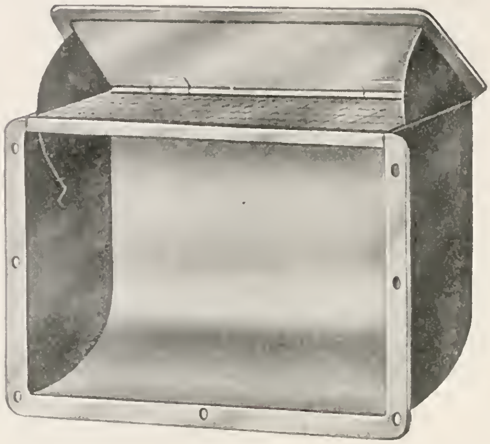


FIG. 181.
Inside of interior diffusion box for square ventilator.

flowing through the openings provided, and in this manner creating a continuous air flow.

The capacity of these ventilators, which are to be put into

FIG. 182.
Oblong ventilator for sash installation. Interior hood.

windows or walls, as the case may be, have been figured by experts, but these figures are not as reliable as they should be, owing to the fact that all such ventilators are subject to the ve-

locity of the air currents. A fair average has been taken of the air moving at 20 miles per hour. Nevertheless, it is not safe to figure on a capacity with such a velocity, and a minimum is therefore taken for the basis of their calculations—ten miles per hour being such a minimum. This is equal to 880 feet per minute, and would give the capacity of the air intake on the following sizes of ventilators:

3-inch ventilator .... 65 cubic feet per minute
5-inch ventilator ....108 cubic feet per minute
7-inch ventilator ....150 cubic feet per minute
9-inch ventilator ....193 cubic feet per minute

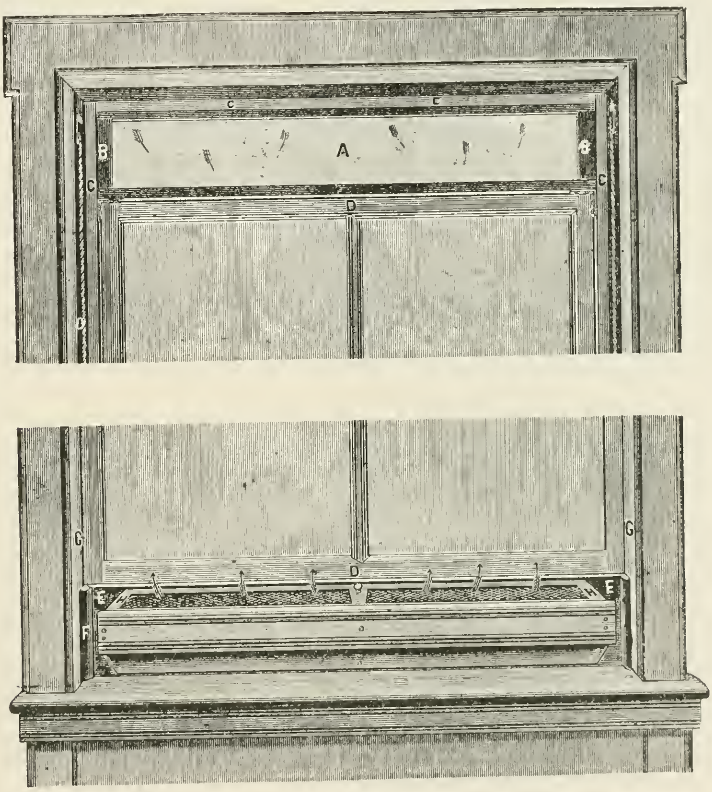


FIG. 183.

The capacity of the oblong ventilator can be figured from this, and owing to the fact that it is more easily adapted to constructive detail, is the one recommended.

A very simple method devised for heating and ventilating is the direct, indirect method, one which has been used to some extent in hospitals. The heating is all direct, the air coming in through louvers, passing through a register which can be opened or closed at will, back of which is an extremely fine mesh screen which is removable, so that it can be readily cleaned (Fig. 185). All the

air goes into a duct, two screens made of cheesecloth and removable being interposed. These can be made damp and changed as required. At the bottom of the duct are two small doors, through which can be placed a pan of water. This will serve the double purpose of taking up the particles which may get in and of giving humidity to the air. The air falls directly over the radiator through the duct, and this duct, being back of the radiator, the chill is taken off the air primarily. It then rises and traverses

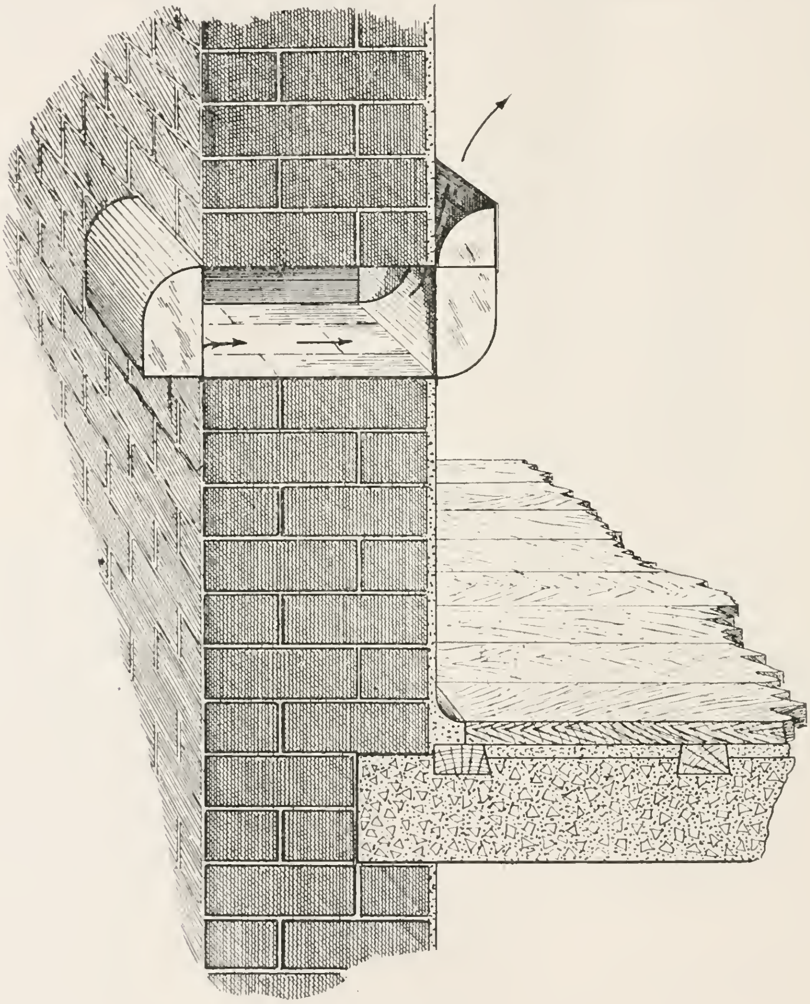


FIG. 184.

the entire room to the duct at the floor, which leads to a large air chamber in the attic space between ceiling and roof, giving room for a great volume and thus a regular circulation. This attic space is ventilated by a shaft thirty feet above the roof and may be made to work either naturally or mechanically, the first by means of a cowel facing the aperture from the wind and so creating a vacuum directly in front, and a plenum state directly behind

the shaft. A simple mechanical process is the placing of a radiator of large capacity at the base of the shaft or duct and so creating a current of air by convection. An ordinary gas jet at the bottom of each shaft will in many instances suffice. This method has many strong advocates. With this system all screens should be of uniform size, so that at regular intervals they can be changed in the entire building. With the help of an orderly or janitor a nurse can do this. The work requires intelligent supervision, but

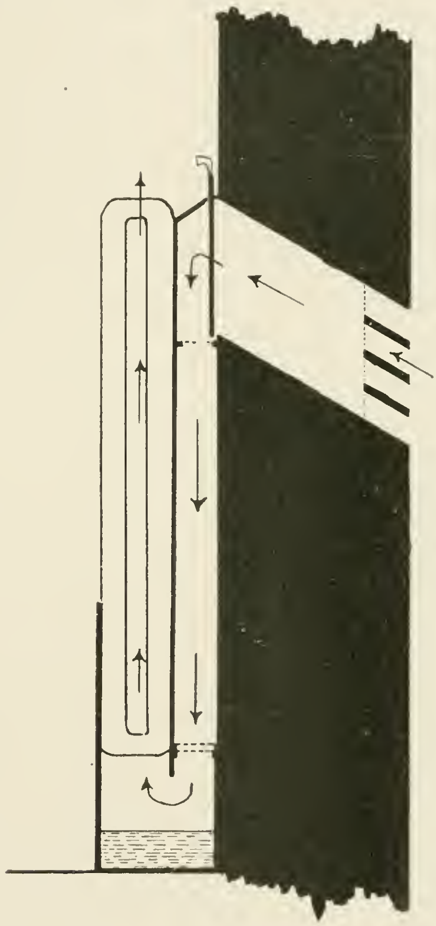


FIG. 185.

this in hospitals is easily obtained, as the superintendent of nurses could have the entire matter in charge. Corridors as mentioned can be used instead of the above method.

Though little heed may be given to Nature's part in the process, the correct designer of a method for air diffusion must yet appreciate the necessity of evenly distributing and diffusing the air employed. If he is versed in methods, or resourceful in devising them, he will be able to suggest a variety of courses to be

followed, according to the circumstances which may require or favor them.

Distribution may be effected by either of the following general methods: First, through a multitude of scattered and well-placed points for inflow and outflow, or by a single point for outflow and many and distributed points for inflow.

The usual and the usually adequate method is to concentrate either the inflow or the outflow into one, two or more points, and to so distribute the apertures for the opposite service as to effect the desired distribution.

For certain reasons to be now mentioned preference is to be given to a diffusion of supply and to a concentration of discharge. First, if wards are warmed by the air which ventilates them, heat is better distributed by issuing into a large room, as a ward, at many points, rather than at a single point. In the second place, draft effects are much less for equal volume movements and equal apertures when they converge for discharge than when the concentrated current of inflow continues its shaft-like course athwart the room. An indraft of air will move in more or less compact current from one side of a room to another, or through the entire length of the ward, whereas outflowing air moves towards its exits through that part of a sphere which is made possible by the conformation of walls and floors, and the flow becomes perceptible as a draft only with more or less close approach to the aperture of discharge. Therefore, concentration in outflow is less open to objection than aggregation of inflow.

The most convenient, as well as the most effective, place for the inflow of air into wards is beneath windows. Fresh air is then issued into the wards between beds and close to patients, and the current of cold air flowing down over the windows is met and neutralized by a flow of warm air rising upwards beneath the windows. Ideally, such an inlet should be beneath each window. If, however, they are placed at alternate windows, each bed has then a supply furnished on one side. The unused wall space between cots at the remaining windows affords table accommodation to each bed. The position of the register in such a location should be high enough above the floor to prevent the register box from becoming a dust receptacle, and low enough below the window sill to issue the air sufficiently near the floor to prevent coldness at the floor level.

With such an arrangement for warm air inflow, the location of discharge may be through a single large fireplace and flue at one end of the ward, provided the ward is intended to accommodate not more than ten or twelve beds. Roughly, then, in accordance

with such a plan, each twelve beds should be furnished with not less than six inlets, and with not less than one ample and well-located vent.

Other parts of hospitals than wards require adequate, and in some cases special, ventilation. The operating room calls for exceptional treatment, both in the matter of ventilation and warming. The depressed condition of the vitality of the patient makes free ventilation imperative. The heat must be uniform and thoroughly under control in the coldest weather, day and night, so as to be available in case of emergency operations.

At times the temperature of operating rooms becomes oppressive from overheating and from anesthetic fumes. Quickness of air change is then called for. The change desired can best be effected by giving strong exit to the air of the room from its ceiling, where air is hottest and vapors are densest. The air is commonly and properly discharged from such rooms at ordinary times near, or at, the floor. If the area of the floor-discharge airway is of proper size, the flue having connection at the ceiling may be within easy reach of the surgeon or his attendants. The current which controls the fan may also operate a damper for closing the opening when the fan is not in operation and for directing the outflow to the vent at the floor of the room. It has been found by experience that by the use of such a single device the quality of the air of an operating room may be given the quick change desired for the reduction either of temperature or other oppressiveness or offensiveness. If the room is of the amphitheater type, accommodating a large number of clinic observers, a fan of suitable size and power to meet the special conditions is required.

A better way to accomplish this change of air is to make the ventilator automatic so that the air-flow is slighter in degree than when the fan is in operation.

In climates of central and northern American cities the carrying off of the oppressive air can be accomplished by ventilators in the skylights over the room, which can be opened or closed sufficiently to equalize the air. The great difficulty has ordinarily been in the opposite direction where artificial ventilation has been supplied—i. e., cold air falling from the large glass area. This may be overcome by building all skylights double, as shown in Figs. 64 and 88.

For the ventilation of sanitaries, bathrooms, lockers and of other quarters, a slight reduction of air pressure within such rooms should be maintained in order to insure a flow of air toward and into them from adjacent quarters. It then becomes necessary to produce in the vent-flues for such rooms a stronger

aspirating action than in the ordinary ventilating-flues of the building. There must be an excess of "pull" to move a larger air volume than is moved by other flues. The pressure per square inch should be greater than is the pull in vent-flues discharging air from other and ordinary rooms, but the area of the flues may be small in proportion as the "pull" is strong. To effect such excess of "pulling" in the flues in which it is desired, and when dependence is placed upon gravity action for the production of ventilation, it becomes necessary to heat such flues by some appropriate means, such as steam coils, hot water coils, gas or lamp flame. The temperature of such flues should be raised above the temperature of the flues ventilating ordinary rooms by an amount equal to ten or fifteen or sometimes twenty-five degrees. Roughly speaking, when such flues are heated by steam surface the minimum amount of that surface which can be safely used is five square feet to each one square foot of cross section of flue.

Very much, perhaps not too much, has been written and spoken in regard to the importance of keeping airways, both supply and discharge, scrupulously free from dust and dirt. Cleanliness is the first essential; to it ventilation is secondary. Dustiness and dirtiness are less of a menace, however, in some places than in others. If the dust is in a flue through which air is continuously passing outward from a room, the room is in no way endangered by the presence of such dust and dirt. If, on the other hand, the menace lurks in the airway from which the room is supplied, the danger is the greater.

The principal danger arising from dusty vent flues is in possible draft reversals, which may carry with them the objectionable dust into rooms. If, for no other reason than for the sake of cleanliness, all lodging and hiding places for dust are to be avoided. As far as is practicable, all airways should be accessible for the purpose of inspection and cleaning. For this reason, the mouths, throats and duct-ways of flues, both for supply and for discharge, should be as open and as accessible as are fireplaces and their flues.

The substitute for Nature's method and work is ventilating mechanisms, as the fan, or a propulsion of air through ducts by heating the former. The two methods are designated *Mechanical* and *Gravity* ventilating, respectively. The larger part of ventilating work the world over is to-day, and doubtless will be, done without mechanism.

Where the airways for ventilating work can be large enough, and high enough, and where heat need not be used for the sole purposes of producing ventilation flow, there ventilation by grav-

ity action is always admissible, and often, if not generally, preferable. When the ventilating work to be done is small, and even when the volume of air used is large, but its use is intermittent and at long intervals, then gravity or natural, rather than mechanical, ventilation is found advisable. Small and intermittent ventilating work does not warrant the expense of an adequate and largely idle equipment and the salary paid to a competent engineer.

This phase of the ventilating problem resolves itself into one of operating profit and loss, into which enter too large a number of factors for discussion, or even mention, in our present study.

In general, however, this rule may be followed: When ventilation is to be continuous, as in a hospital; wherever the air volumes are, or should be, large; where airways are long, or small, and the velocity of air-flow must be high; where power is available in steam used for other purposes, or in electric service, or in an inexpensive water head and flow, or even when gas or like engines can be advantageously used; when required attendance may be given by those already employed for other service—then the conditions are favorable to, and frequently require, the use of mechanical ventilation.

An argument made in some quarters against mechanical ventilation for hospitals is based on the necessity of quietness about the sick, and on the assumption that the use of mechanism necessarily involves the noisy whirl of wheels, or the rumbling or clattery of machinery, or the whistling or singing of the air as it frolics into or frisks out from rooms under the propulsion of the fan. All such noisy nuisances are quite as avoidable as they are possible.

A frequently used substitute for the fan is heat in vent flues. To warm air for admission to buildings is quite costly enough. To again heat it as it takes its flight from buildings is to increase expense in a manner to be justified only when other equally effective methods would be equally or increasingly costly.

Because the flue-heating method is simple and easily applied, and because its costliness is current, slowly cumulative, and not conspicuously evident, it is often employed to the user's loss. To move a cubic foot of air into a building through a heater and fan, and through flues to rooms and through rooms into and through vent-flues, and to discharge it outboard, all requires a power rarely reaching and never exceeding that required to raise ten pounds in weight through one foot against the pull of gravity. In a well-designed, accommodated and installed system of ventilation the

work expended on each cubic foot of air moved through it should not exceed from five to six pounds.

If, on the other hand, that cubic foot of air is made to move through the ventilating system of the building by giving to it a rise of temperature of ten degrees, for the purpose of producing an acceleration of flow, the power-equivalent of that heat is 10 pounds raised through more than 14 feet against the pull of gravity, instead of 10 pounds raised through one foot. If only one-twelfth of the heat produced by fuel combustion is convertible into power, and if the exhaust steam of the engine furnishing that power is wasted, the cost of moving the air by raising its temperature ten degrees and the cost of moving that air by exceptionally hard fan-work are then about equal. If, however, the exhaust steam from the engine driving the fan is used for heating purposes, the largest cost which we may consider allowable by the fan method is about one-third of that by the heated-flue method, when the rise in flue-air temperature is but ten degrees. The higher the rise of that temperature the greater the loss.

Fan-ventilation is, therefore, to be generally recommended for large hospitals of complicated plan and construction, where airways must be small, tortuous and long, and where gravity cannot be given generous provision for its own moderateness and variableness of work.

The heating of hospitals should not depend upon the ventilating air as a carrier. The systems should be entirely independent, each a unit in itself, for the following reasons: At best a ventilating plant is so uncertain in its operation until it has been thoroughly tested that to make the ventilating air the vehicle also for heating is to put the latter in doubt. What will work properly in one building will not necessarily do so in others Precedent is absolutely unreliable. We are dealing primarily with a theoretical problem, and while theory may be correct to the minutest detail, the practical working of the plant is dependent on so many things that it is not safe, especially in colder climates, to depend upon them until they have proven eminently satisfactory. Direction of wind, general conditions as to building material and natural leakage of air through these, all may tend to upset the most careful calculations. Not that ventilating is not an exact science so far as it goes, but rather that no two problems present the same latent conditions.

The element of chance enters largely into all calculations of this character. Heating follows the same indecision at times, for the amount of radiation necessary for the rooms of exactly the same size, exposure, window area and general location will be

found to require different amounts of heating surface. In the case of radiation this is easily corrected, inasmuch as additional loops can be added. In ventilating work, however, owing to the necessity for making the ducts a minimum, rather than a maximum size, so that they occupy as little of valuable space as is possible, corrections are not possible, as such ducts are built in and are an integral part of the building.

Hospital ventilation, it is granted, must be made free; that is, the air quantity must be abundant, and while this abundance may be sufficient for conveying heat to the different parts of the building, this indirect method of heating is not to be depended upon. It is not certain enough in its action, nor is it economical; in fact, it is the most expensive form of heating. If, however, this method is used the coils for heating the air to warming temperature should not be heated by steam. The air passing over the superheated steam coils is deteriorated by scorching and the odors and quality peculiar to such air are neither agreeable nor hygienic.

The coils for this purpose should be heated by hot water and a sufficient quantity of this should be supplied so that it can be maintained at as low temperature as is consistent with the proper warming of the hospital. The temperature should not exceed 160 degrees F. The air flow, then, being rapid over these coils admits of none of the deleterious effects of superheated coils.

This has, besides the reasons stated, the element of economy mentioned. First, because of the transfer of a larger proportion of the heat combustion to radiators than when steam is employed; and second, because of the easier and more complete regulation of the building temperature, which makes less liable the overheating of rooms in mild weather, and the opening of windows for relief and the larger waste of heat attending that practice. In spring and autumn in the cold climates, and in the winter months in milder climates, the heat necessary may all be supplied for warming by this method, as it would be sufficient to take off the slight chill.

AIR FILTRATION AND WASHING.

The matter of washing air for ventilating work when fan systems are used is as prolific of methods as is ventilating itself. There are several methods which have been successfully used, and these are given here. All air, however, for ventilating purposes when fans are used should first be conveyed to a settling chamber, which is a large space in the attic or basement in which the air is permitted to come somewhat to rest and to permit

the larger dust particles to settle out. This room must be kept clean. The basement room is not recommended, owing to the danger of contamination of the air by soil air and other gases. The most effective method for making such a room sanitary and clean is to line it with tin or galvanized iron or to build the entire room of sheets of the latter with tight joints and stiffening rods.

If it is not possible to provide chambers large enough for this settling of the air, a very good method is shown in Fig. 186. This consists of admitting the air into the building through the ordinary intake and dividing this into smaller ducts whose total capacity is somewhat in excess of the main duct, and at the bottom

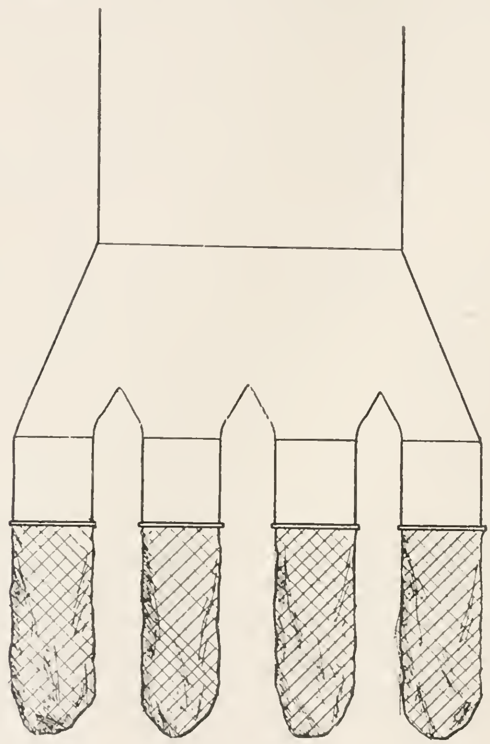


FIG. 186.

of these securely fastening a double thickness of gunny-sack. This serves the purpose of removing the larger particles of dust and leaving only the minute particles for the washing apparatus to remove. These sacks should be removed at least once in every two or three days, and others put in their place while the first are being cleaned.

The best methods of cleansing air are the natural ones. Air which has been carried across a large body of water is practically free from impurities, because these have fallen into the water. Air near the tops of high mountains is pure because impurities fall to the ground before they are carried to great heights.

In tall buildings there are more micro-organisms in the air entering from without in the lower than in the upper floors.

For these reasons it seems wise to obtain as large a piece of land as the means will permit, on the highest available piece of

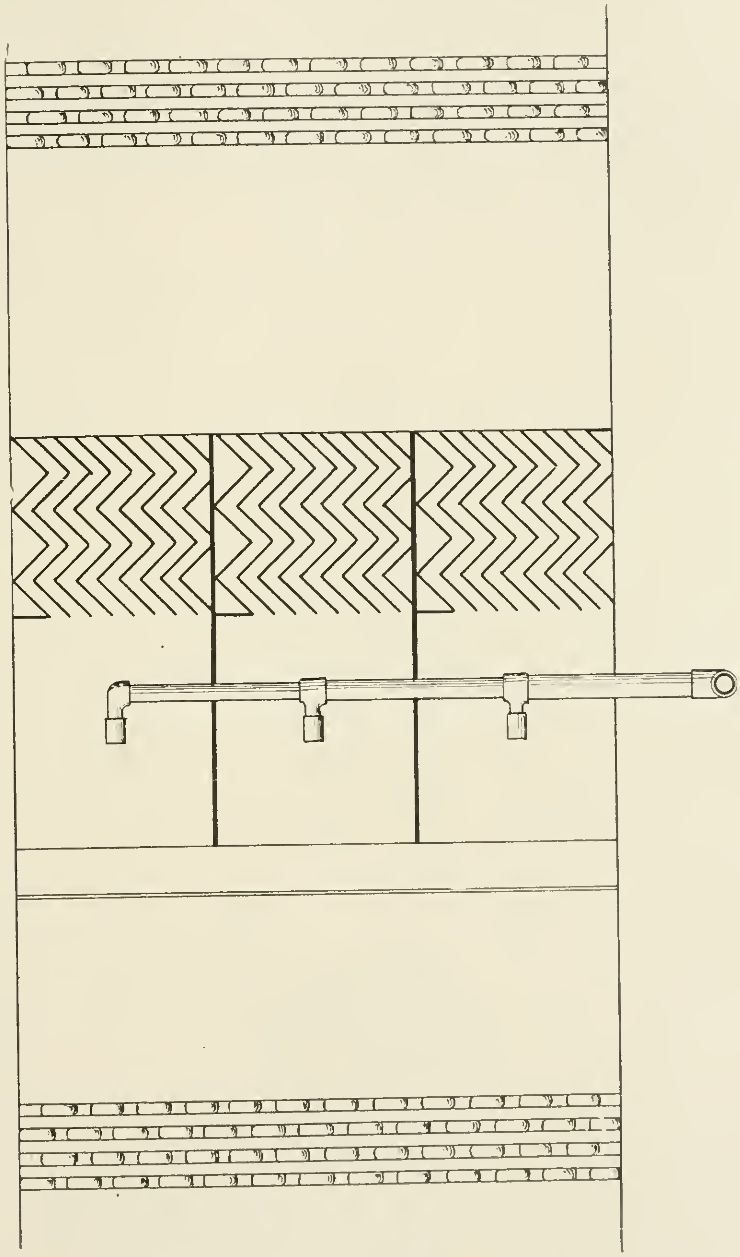


FIG. 187.
Plan of washing apparatus.

ground and then to construct buildings as near the center thereof as possible. The higher the buildings, the better will be the chances of obtaining good air for the greatest number of patients.

Shrubs and trees planted between the building and the surrounding streets will serve to filter a considerable portion of the street dust out of the air before it reaches the building.

In forcing air into a building for the purpose of ventilation it

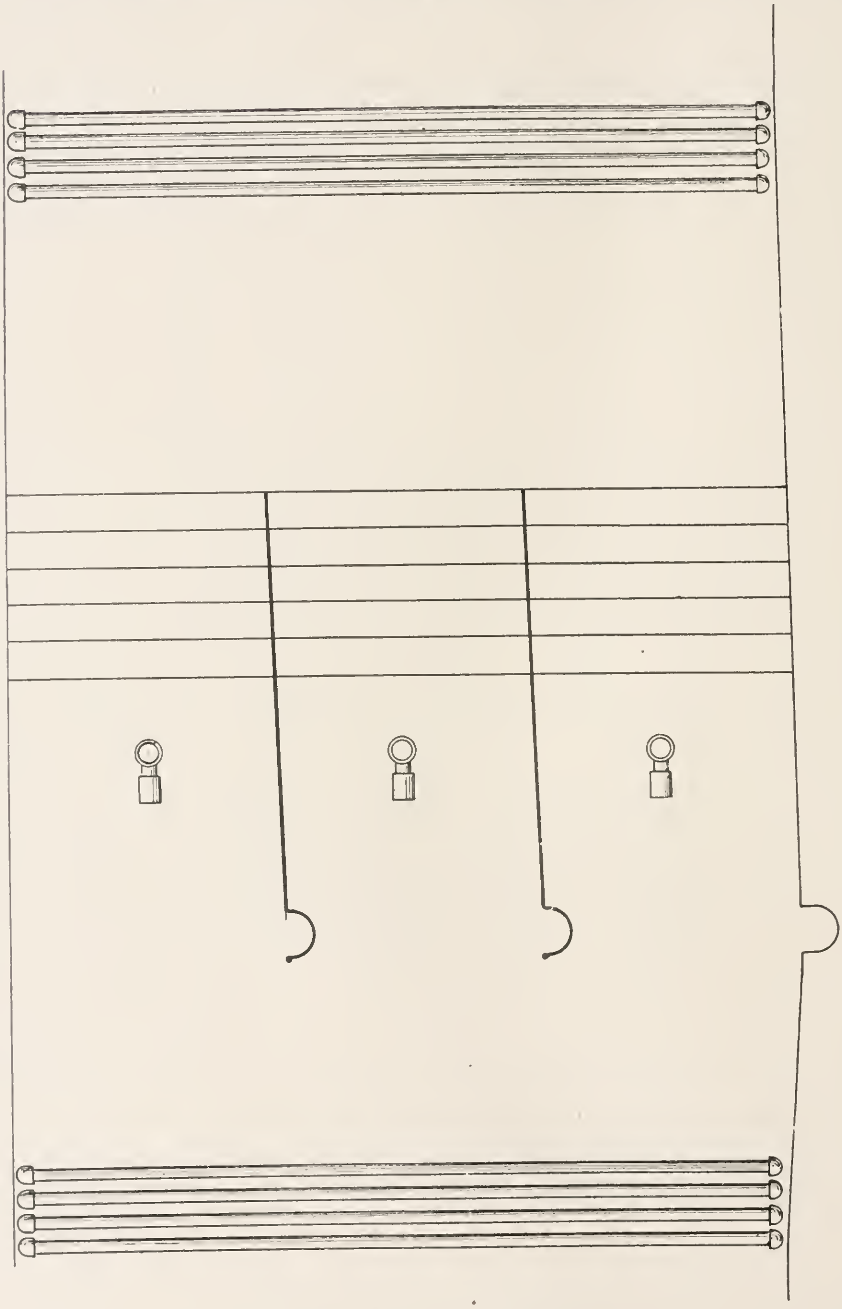


FIG. 188.

is possible to select that which is relatively free from dust and impurities if the intake has its opening at a good height above the roof of the building, but in such a position that the prevailing winds will force the impurities which come from the chimneys and vent pipes away from the intake.

Many devices have been instituted for the purpose of washing the air which is forced into a building by fans. Streams of water are permitted to drip over moist gauze or other substances in order to intercept the fine particles contained in the air. The advantage of this treatment of the air has, however, not yet been

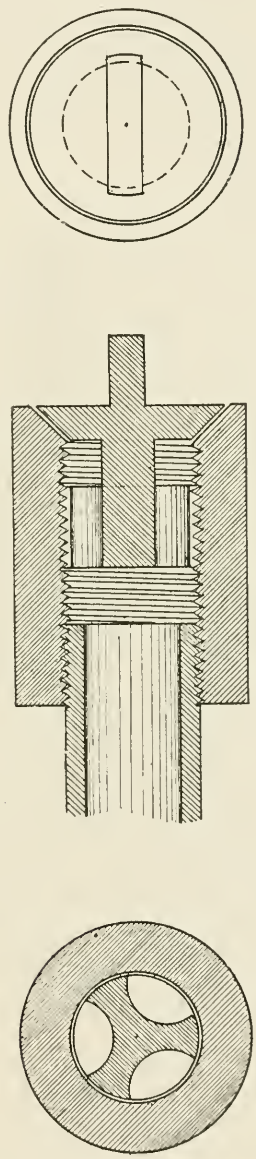


FIG. 189.

fully and satisfactorily demonstrated, although many authorities speak well of it.

A method which has been used frequently by the government in some hospitals, and especially in its larger office buildings, is to heat the air above freezing point and then pass it through a

wall of finely sprayed water. One excellent method of doing this is shown in Figs. 187, 188. A small pump driven by the same power that drives the main fan returns the water with sufficient head to make the sprays. Fig. 189 shows the spray-head. The small compartments are about eighteen inches square, so as to keep the water from spreading, and thus making a fine spray instead of a very fine continuous film. As will be seen in the illustration, the air strikes the continuous screen of water, which takes up the dust particles, and these run to the gutters and thence to a main tank. From this

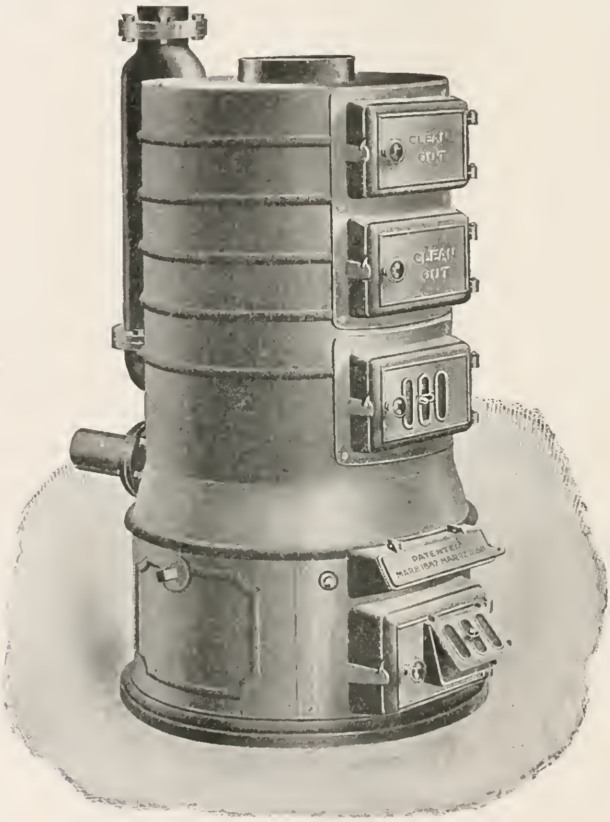


FIG. 190.

it goes through filters and is then returned by the pump. The filter must be kept clean and free from dirt at all times. The air passing through the water screen contains a quantity of moisture in excess of what is good for ventilating purposes. The angled surfaces of copper permits the air to strike on the plates in such a manner as to virtually "shake out" the unnecessary water particles. This is partly due to the deviousness of the path of the air and to the natural condensation on these plates. The air goes from these plates into a drying room and from there into a space where a fine spray gives it the requisite moisture, the drying room

being kept at a temperature so that the air goes out to the several ducts at a bit higher temperature than that of the rooms.

The system has been found very satisfactory and simple. It is also economical in operation, owing to the fact that the water can be filtered and used over and over with renewal for loss.

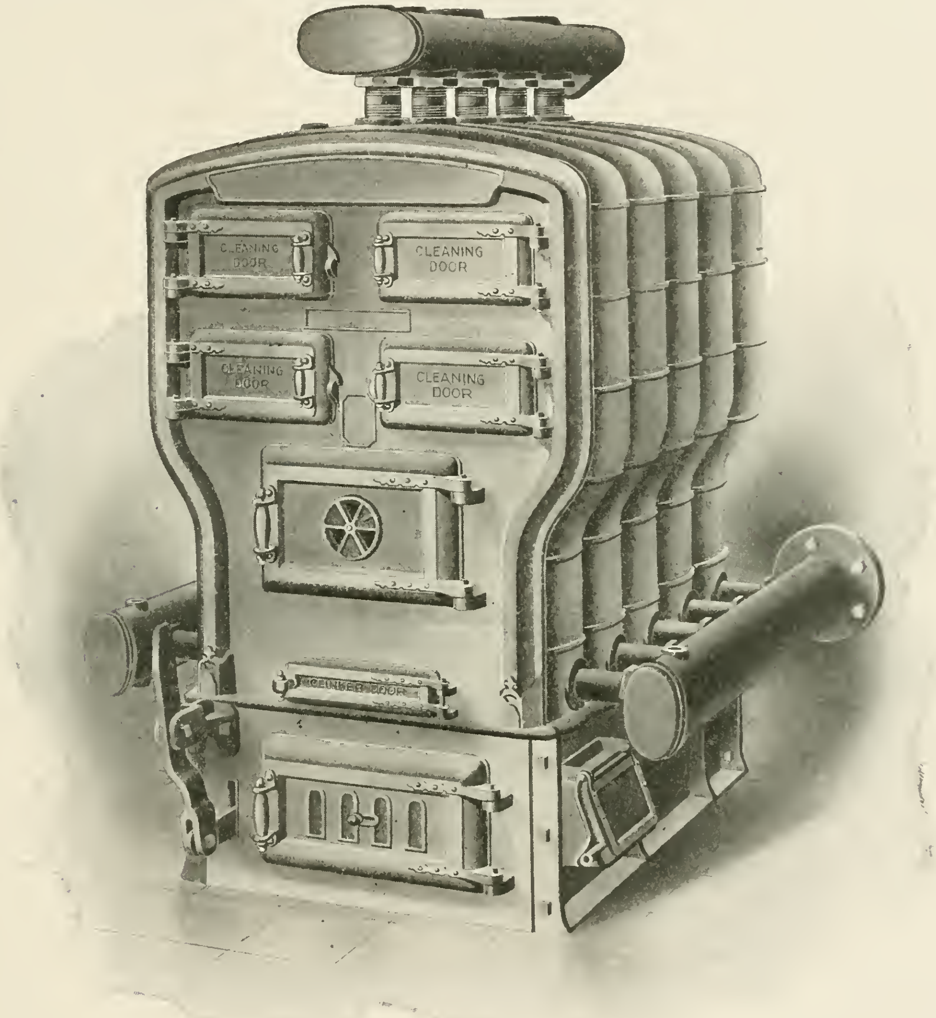


FIG. 191.

In general all ventilating systems, natural or mechanical, must supply a sufficient amount of pure air at all times, which has not been spoiled by overheating, which is delivered throughout the hospital without draughts and at an expense which is within the means of the hospital for maximum results.

HEATING.

Heating may be done by one of two methods—hot water or steam. The primary principles for these are practically the same

namely, that there should be sufficient radiation for each and every space to be heated. An excess of radiating surface is to be desired at all times rather than "just enough," or too little. The pipes should be sufficiently large to do the work noiselessly and positively; the boilers of whatever type should have sufficient capacity to easily take care of the radiation with an excess added, whose minimum should be at least 50 per cent. greater than the radiation supplied. This latter requirement has the great advantage of positive work and the item of economy in its favor. This reserve allows for main risers, flow and return pipes, which must be considered as radiation, and a twenty-five per cent. reserve capacity, which allows for leakage of air into the building through natural means and through faulty fitting doors and win-

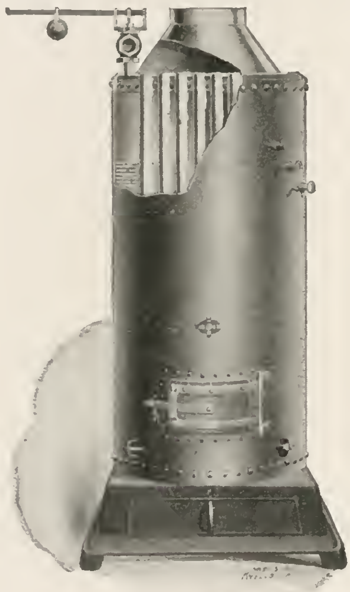


FIG. 192.

dows. An expenditure of 10 per cent. added to the first cost of a boiler of just sufficient capacity is so small that it cannot be mentioned as an expense. Moreover, an apparatus which needs no "crowding" to maintain a given temperature will make a saving within one year on coal consumption alone which will more than pay the additional cost.

BOILERS.—Boilers are of two types—cast iron and those made of steel in plate form. There are several types of each of these—namely, the round boiler where the sections are superposed, and the square boiler where they are set horizontally in the cast iron type, as shown in Figs. 190, 191. These boilers are not adapted to pressure work, and are designed solely for either low pressure steam plants or hot water heating plants. Of the wrought steel

type there are upright tubular boilers, locomotive fire box boilers, and the horizontal tubular boiler with furnace attached. Of the latter there are again several types—namely, the Marine boiler, and the internally fired boiler. Furnaces for the tubular type are of so many varieties that it would be impossible except in a separate treatise to mention them all. Fig. 192 shows the upright tubular boiler; Fig. 193 shows the locomotive fire box boiler, and Fig. 194 shows the tubular boiler with furnace.

The existing conditions, the amount of variation necessary for heating the building, and the general structural features of the building will be the best guide for the type of boiler to be used in any given case. In the fire box and tubular type of boilers it will be necessary to brick the boilers in masonry. The boilers

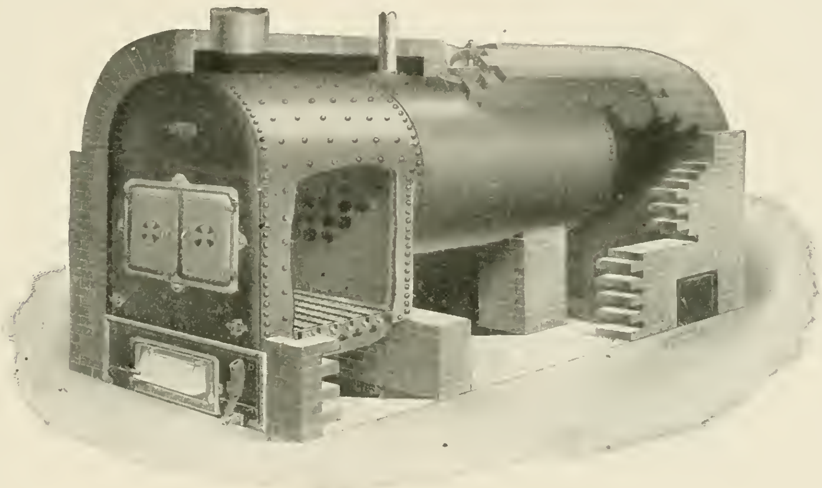


FIG. 193.

should be set on good concrete foundation, and the side walls from these foundations should be made of good, hard-burned brick to the thickness of twelve inches, so built as to form a return flue, so that the products of combustion will pass through the flues, thence down under the shell of the boiler, and then rising to be carried over the top of the boiler to the smoke flue. The upper shell of masonry should be thoroughly plastered over with asbestos cement.

In the horizontal type of cast iron boilers, and also in some instances in the round type, a heavy coating of asbestos cement should be put on at least four inches thick, and the whole thoroughly covered with canvas. The capacity of these boilers is mentioned elsewhere and should be carefully considered.

If more than one boiler is used, and this is thoroughly advocated in all instances, cross-connection should be made by means

of angle valves so that both boilers can be operated at the same time or either independent of the other. These angle valves are to be iron bodied, brass mounted and equipped with an iron wheel. In hot water heating, it will be necessary to follow the same course on the return.

The great advantage of a double battery is the fact that in mild weather only one boiler need be used, and also in the fact that in case of accident to one boiler the other can still be operated, without the necessity of closing down the entire plant.

Smoke Breeching.—The breeching from the boilers or the smoke pipe which runs to the chimney flue should be made of sufficient heaviness to insure its not warping, and should not be of less gauge than No. 12 galvanized iron, and the area of this should not be less than 25 per cent. greater than the combined boiler flues.

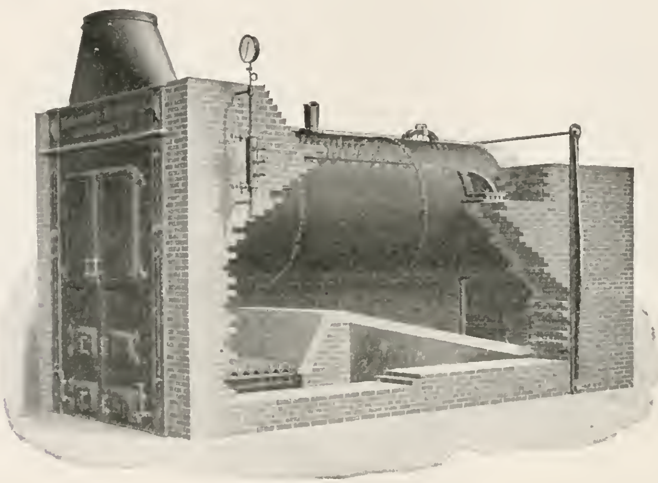


FIG. 194.

This also applies to the chimney area, which must be carefully calculated. It will be necessary to put into the breeching a clean-out door and the necessary dampers.

Coil Opening.—As will be noted under plumbing, coils for the heating of the domestic supply of water in the building are sometimes put into the boiler to act as auxiliary to the small heater or the garbage crematory, which is put in for the special purpose of heating the water. Such auxiliary coils are used more often in small institutions rather than in the larger ones. The opening for these coils should be placed well above the grates, and about 14 inch centers, and the pipes to these should not be less than two inches in diameter. In nearly all cases this can be done very readily without interfering with the fire and still be made very effective. A valve should be placed on the pipes outside, so that if it is necessary to close off this part of the water heating

system, it can be done without interfering with the remainder of the system.

Radiation.—Direct radiation should be selected with due reference to plainness, smoothness and accessibility to surface for cleaning. All radiators should be placed next to exposed walls and as near windows as possible, as these are the coldest portions of the room. In general the rooms to be warmed must each be given the amount of radiation for the proper warming of the space. The calculation for this depends upon the size of the room —namely, cubic contents, amount of exposed wall area, the quantity of glass in the room, the height of ceiling and the position of ventilators.

"In the matter of warming as well as of ventilation, the operating room furnishes opportunity, if not necessity, for special treatment. The effect on the patient of the large exposure of chilled window glass should be compensated by a correspondingly large heated surface. That surface may be in pipe form, carried about the window frame and over mullions and other parts of the framework, in a manner to be neither conspicuous nor light intercepting. When windows are double glazed, and with ample air space between the plates, that space, and with it the inner glass, may be warmed by steam or hot water pipes concealed from view within the space."

Systems.—As stated above, and for reasons there given, economy favors the use of water at both ends of a system—at the fires and at the radiators. The first cost of a hot water plant, for equal heating work with steam, varies from 30 to 50 per cent. more than the cost of a steam apparatus. The saving in fuel by water boiler heating has been found by careful experiment to vary from 15 per cent. to 20 per cent. as compared with that of doing the same work by steam. The necessity of bringing the water to the boiling point in a steam plant is entirely eliminated in the hot water system, for, as will be explained, the highest temperature used would be 190 degrees. In the mild days of early spring and late fall, a temperature of from 90 to 110 degrees will keep the building at the proper temperature. In chilly days, if a steam plant were installed, it would be necessary to raise the water to a temperature of 212 degrees in order to heat the rooms or to install a vacuum system.

In high buildings—namely, those of five stories and over—an auxiliary pump would be necessary to facilitate the flow of the water in the hot water system. This might be advanced as an objection, due somewhat to the increased cost of such apparatus. This, however, would be offset by the fact that in such buildings,

if steam were used, additional fuel to maintain a pressure necessary to heat the upper floors would be required. Another added

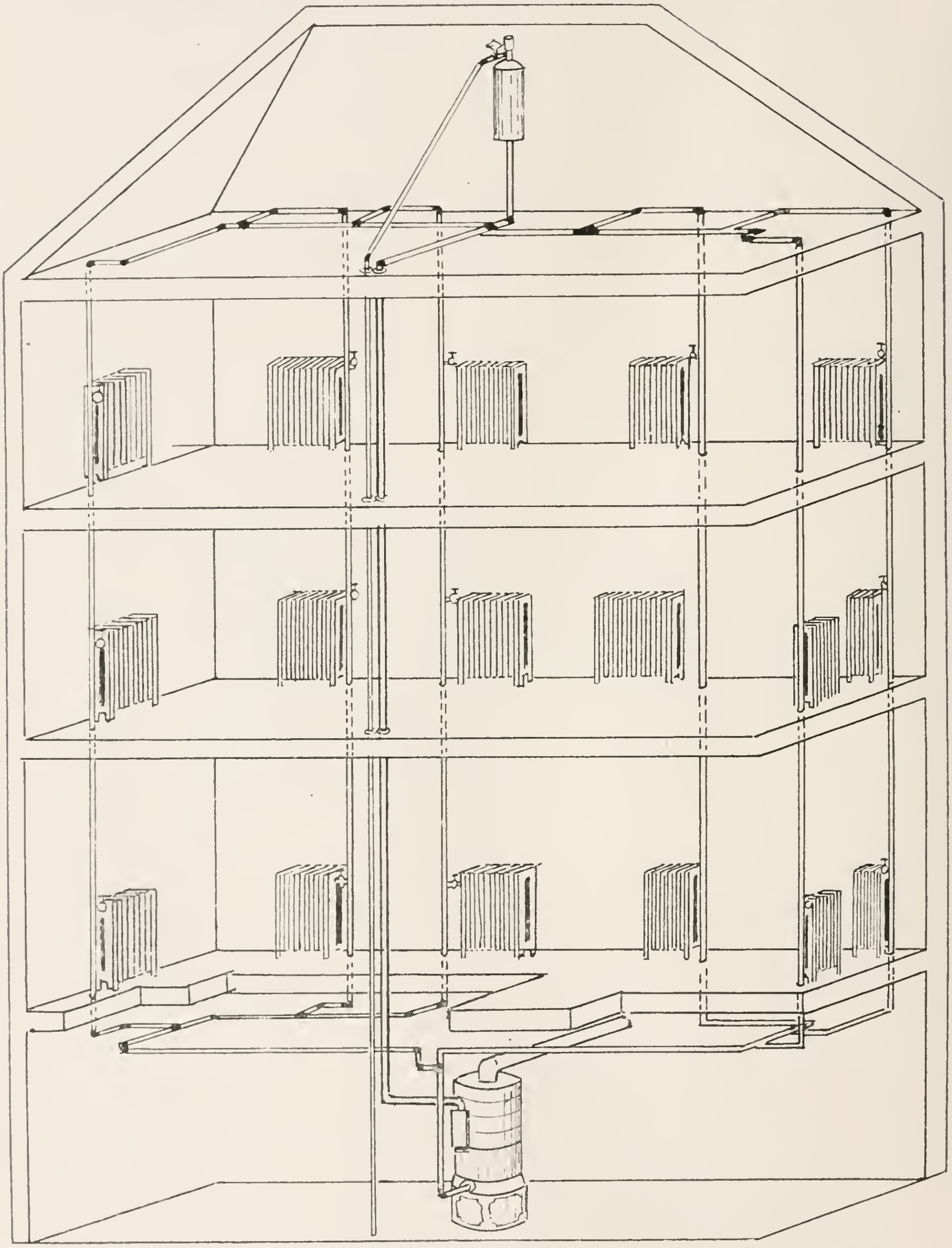


FIG. 195.
Hot water heating. Overhead gravity system.

advantage of the hot water is that heat can be maintained in the hospital over night without additional firing, other than "bank-

ing." The hot water in the system will maintain a good "night temperature," whereas with steam heat, when the fires are banked the pressure goes down and the building quickly cools. Hot water, however, will probably never wholly replace steam, and the illustration of apparatus and methods for both systems will therefore be given.

HOT WATER HEATING.

There are three methods of heating by hot water. The first of these is the Overhead Low Pressure Gravity system. In this system the water is carried to the attic, the highest point of the apparatus, by convection. From this point it returns in all pipes

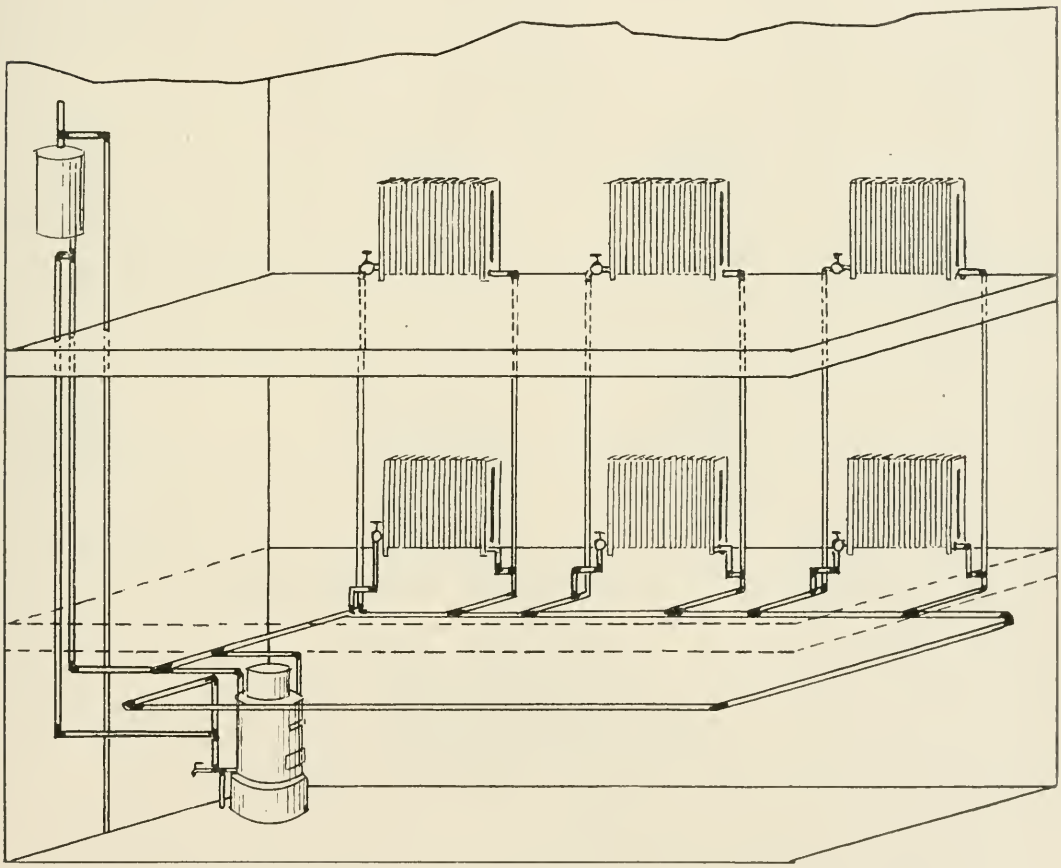


FIG. 196.
Hot water heating. One pipe circuit system.

into a main return, which is in the basement, and which runs to the boiler (Fig. 195). The second and third systems are known as basement or direct systems, the second the one-pipe and the third the two-pipe system. In the one-pipe system, one large main, or one main and several sub-mains, are run around under the base-

ment ceiling. The hot water connections to radiators are taken off the top of the main, the water returning into the side of the same main (Fig. 196).

In the direct system the water rises from a horizontal main into the several branches and returns in others, which empty into a main return in the basement, which conveys the water back to the boiler. Fig. 197 shows such a system. In the latter system it is necessary to place air valves on the radiators. These must be opened when they become "air bound," which they do owing to the fact that hot water expands, and when it cools contracts again to normal, leaving air in the tops of the radiators, which must be

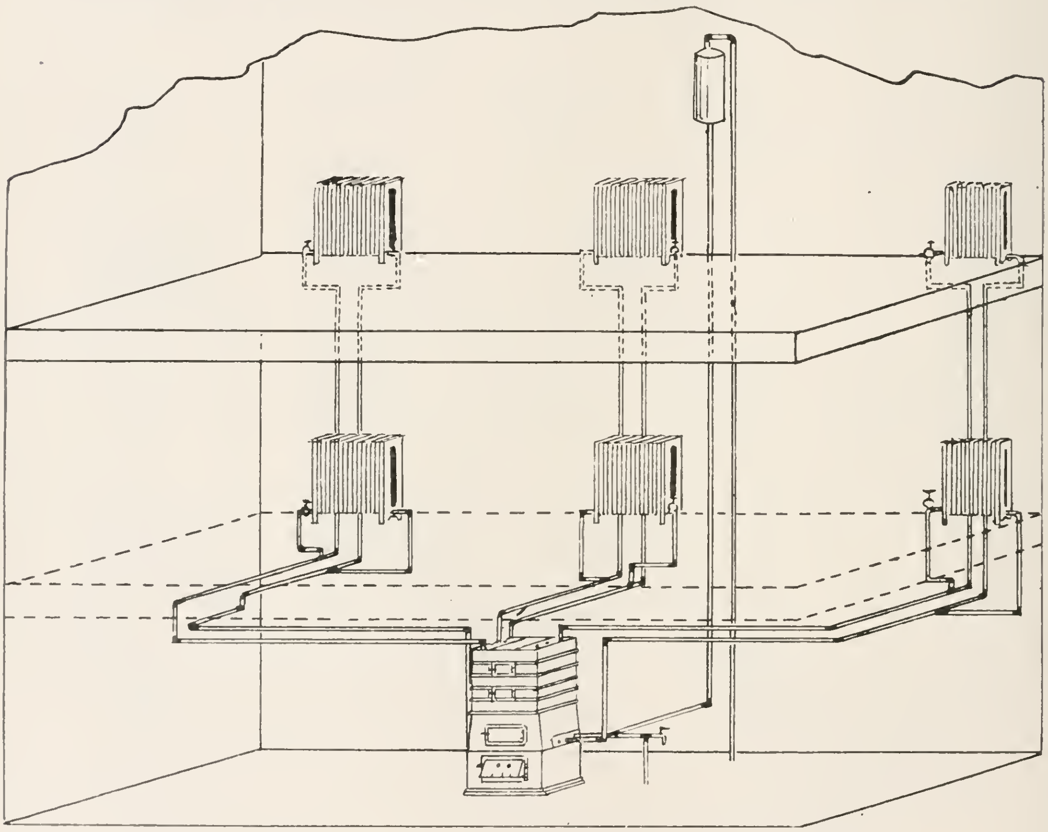


FIG. 197.
Hot water heating. Two pipe system.

expelled before they will again fill. Fig. 198 shows this, as also the air valve.

In both systems an expansion tank is necessary, so that the excess of water under its expanded condition will still remain in the apparatus when it cools.

In the overhead, or gravity, system, no air valves are necessary, as all the air rises to the highest point, as can be seen by the illustrations, and is discharged from the expansion tank, which

is placed above the highest point of the main riser. In the direct system an air vent is put into the expansion tank to equalize the pressure. An overflow pipe from the expansion tank in both systems should be returned to the boiler room, so as to indicate the height of the water under ordinary circumstances without the necessity of consulting the water glass which is put on the tank.

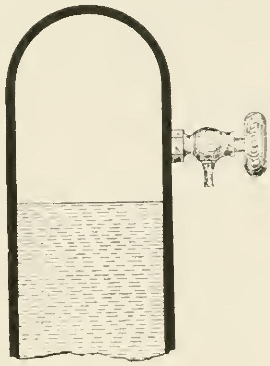


FIG. 198.

VALVES.—All valves used in hot water work to turn the heat off or on should be of what is known as the "quick closing" pattern—namely, those which with either a quarter or a half turn of the wheel will close or open the water flow. All such valves should be selected with extreme care, as the difference in cost between

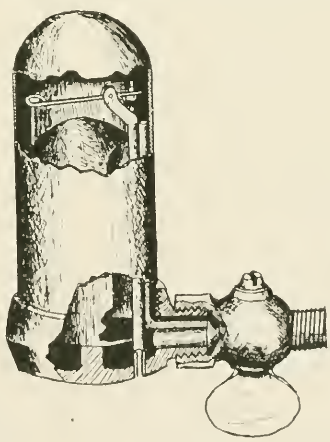


FIG. 199.

the best types and those which are not entirely dependable is so slight that it should not be taken into consideration.

In the direct system it will be necessary, as stated, to put in air vents. These can be of either the handle type, or those which are operated with a key which can be removed and so prevent tampering with the valves. As in other valves, these air valves or vents should be selected with the utmost care, and if they are of

the automatic type, they should have a composition seat over the air vent which will prevent any leakage of water (Fig. 199).

PIPING.—If the system is on the "Low Pressure Gravity," the main riser must be properly supported, so that there will be no settlement whatever in the pipe. It must also be so placed, and the extensions from it taken off in such a manner, that there will be allowance for expansion and contraction without injuring any joints or causing any leaks. From the main riser, as shown in the drawing, the mains are run in the attic, all proportioned to the proper size, and none of these pipes must fall in the direction in which the water will travel less than one inch in every ten feet. It might be stated here also that no pipe in any hot water heating plant should be less than one inch inside diameter.

In direct systems the same care must be exercised in the running of all horizontal mains, and the only difference between overhead and the direct, so far as piping is concerned, is that both supply and return are in the basement in the latter. The size of all mains in both systems, as well as all other pipes, must be carefully calculated, this depending upon the amount of radiation supplied, distance of travel of the water and directness of travel—i. e., number of bends or turns. In the hanging of pipes they should be supported not less than every ten feet on the horizontal runs, and the hangers for these should be so arranged as to take care of the expansion and contraction in the mains.

THERMOMETERS AND GAUGES.—In both systems there should be placed in the flow and return accurate contact thermometers. The object of putting in two of these will be explained later. An altitude gauge to register the height of the water should also be provided in the outgoing main. As stated above, the "tell tale" from the expansion tank would supplement this gauge in indicating the height of the water in the system, as it would overflow when the system was full.

EXPANSION TANK.—The expansion tank, as stated, is always placed somewhat above the highest point of the highest pipe in the system, and should be provided with a gauge glass to indicate the height of the water. It is somewhat better, and is recommended wherever it is possible to do so, to run the feed or supply pipe which fills the apparatus to this expansion tank, rather than directly into the boiler, as the cold water which is put into the system will be heated before it reaches any part of the apparatus which directly contributes heat to the building. From the tank there should also be a circulating and overflow pipe, and a return overflow to the boiler room. It is necessary also to place either an air vent on this tank, or better still, a safety and vacuum valve.

Temperature.—The entire system for hot water heating should be so designed that the inside temperature and the outside temperature are the basis upon which the calculations should be made. That is to say, if the temperature of the room, aside from special cases, is to be 70 degrees when the external temperature is 10 degrees below zero, there should be sufficient radiation and boiler capacity so that the temperature of the water as it leaves the boiler, as indicated on the outgoing thermometer, should not be more than 190 degrees. The difference between the temperature of the water as it leaves the boiler, and as it returns to the boiler, after going through the entire system, as indicated on the ingoing thermometer, which is placed on the return at the boiler, should not be more than 15 degrees. It is to be seen from this that any two points of maximum and minimum temperature can be taken, and it will only be necessary to so design the entire system that this will naturally result.

The object in doing this is not a saving on the primary cost so much as it is a saving on the yearly expenditure, year in and year out, so long as the institution stands. Fifteen degrees is a good working basis between maximum and minimum, with from 10 to 20 degrees below zero as the outside temperature.

In general the main object to be reached in the installation of a hot water heating apparatus is to have sufficient capacity in all of its parts, a quiet and positive working system throughout, and economy at the boilers when once the system is installed.

STEAM HEATING.

Steam heating was formerly divided into two classes—high pressure and low pressure. High pressure steam heating is a system of the past except in very isolated cases. High pressure steam has to do now almost entirely with power. Such steam from the power plant as is used for heating purposes first passes through a pressure reducing valve and is allowed to pass into the heating system at a pressure of from two to five pounds only.

Steam heating may be classified as low pressure and vacuum. Low pressure steam is designated by the system of piping used for its conveyance. To-day we have the overhead or Mills system, the two-pipe system, the one-pipe system, and the single-valve system. This last system has several subdivisions, such as the continuon circuit, the wet and dry return, etc. We will consider simply the single-pipe or valve system.

The overhead or Mills system consists of a main riser to the top of the building, laterals above the highest radiators distributing the steam to the radiator risers with corresponding branches

either on basement ceiling or below the basement floor. Branches for the radiators are taken out from the riser below the floor line at the radiator. This system is very useful in large hospitals, or those having very little height in basement for suitable pitch of the main pipes.

The two-pipe system is one that has been adopted for many years, though not now in general use. It consists of a separate main at basement ceiling with corresponding return at or below basement floor. Each radiator is equipped with two valves, one for supply and one for return. The supply comes from main at basement ceiling, and the return enters the main return at or below the basement floor. Into this return, also at frequent intervals, is connected a branch from the main steam pipe, which acts as a bleeder or drip for conducting the water from the steam main

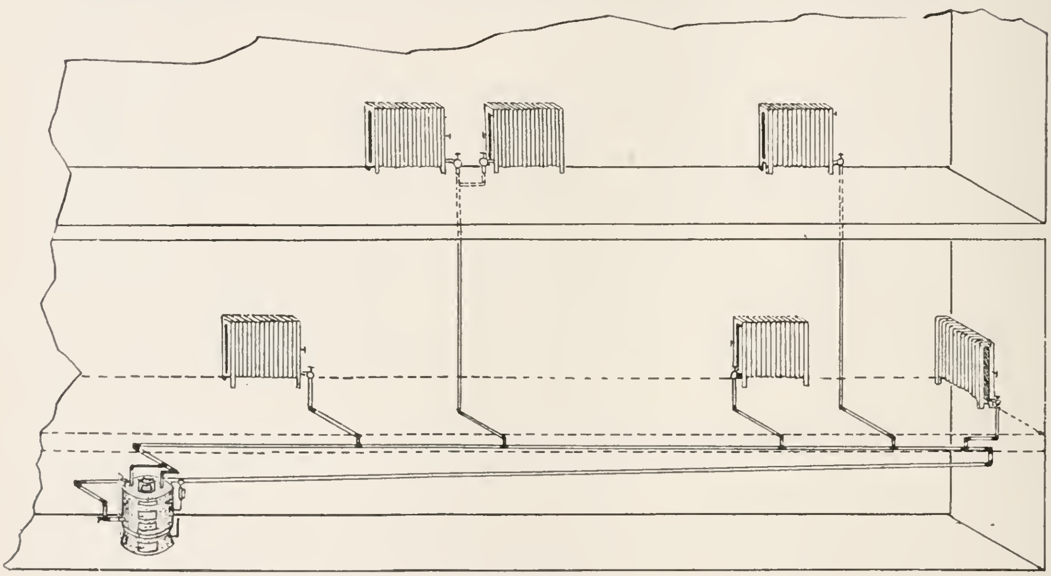


FIG. 200.

Low pressure steam heating. One pipe gravity return.

back to the boiler. In this system the main steam and main return pipes, also the risers to and from the radiators, may be of smaller size than are used in the single-pipe or single-valve system. The double pipe system has one advantage over the single-valve system. By its use the valves may be partially opened without causing the hammering noise noticeable in the other system when valves are not entirely closed or opened. Its expense and the considerable cutting necessary for its installation are against it, though it must still be used where indirect radiation is wanted.

The one-pipe system is nearly, if not quite, obsolete. It consisted of one pipe run from top of boiler to the radiator, the boiler being the low point, so that the steam and water of condensation

traveled in opposite directions in the same pipe, which of necessity was of large diameter comparatively. This system was used very extensively in connection with the old sheet iron radiator (Fig. 200).

The single-valve system is the one most in use at the present time, having steadily gained favor since about 1880. In construction it is the reverse of the single-pipe system (though often misnamed the single-pipe system). The high point in the main pipe is at the boiler. The main pipe may be what is known as a continuous circuit, in which case it starts high at boiler, gradually falling as it passes around the basement back to the boiler, where it abruptly drops, entering the boiler at the bottom. The water and steam in the main travel in the same direction. The laterals or branches to the radiators are taken from the top of the main and the pitch is from the radiator to the main, the water and the steam, as in the single-pipe system, thus traveling in reverse directions only in the branches to the radiators. The philosophy of the single-valve system lies in the fact that the transverse area of its one pipe and one valve equal nearly the transverse area of the two pipes and the two valves of the two-pipe system. As before stated, it is very necessary that the valves on the radiators of this system should be operated intelligently, as a valve opened partially, while permitting the steam to enter, will not permit the water (the result of the condensation of steam) to return to the boiler. The least that can happen under these conditions is a very considerable noise in the radiator when the valve is opened until the water leaves the radiator.

Valves.—The radiator valves should be of the best quality, and of such a type as has absolutely been proven to be effective, and under all circumstances these valves should be supplied with a Jenkin's disc. The air valves on the radiators can be one of the several types mentioned, but the entirely automatic valve is not to be recommended. There should be some form of adjustment on every valve, so that the condition existing can be met, and the air escape should not depend upon a general condition. Valves are now to be obtained made in such a manner that from the air vent of these valves there is a small pipe which is run out of the room, so that the odors usually accompanying the discharge of the air from the radiators is entirely overcome. Air valves are used on all radiators in steam heating.

The effective working of these valves depends upon the expansion of a metal drum, which closes the air vent when this drum expands under the action of the heat of the radiator. This permites of the cold air in the radiator being expelled, and as soon as

the radiator becomes hot the drum expands as stated and closes off the escape (Fig. 201).

The thorough cleaning of the steam heating apparatus before permanent air valves are placed cannot be too greatly emphasized. Even in a well-constructed apparatus oil and sand will cause faulty working.

PIPING.—The area of the main pipe in steam-heating work

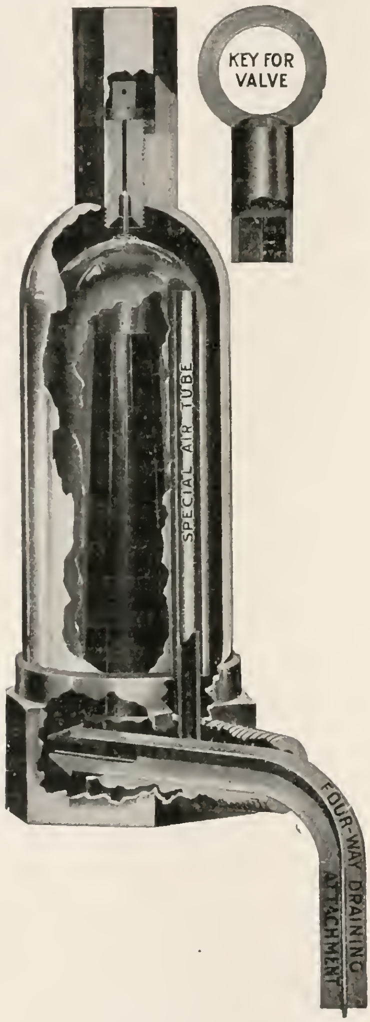


FIG. 201.

must be equal in capacity in every case to that of all of the branch pipes taken off this main. As its distance from the boiler becomes greater, it may consequently be reduced in size, but the decreased pipe must follow the same rule as applies to auxiliary pipes. It is, however, more economical to run the main full size than to fit it with reducing fittings.

TEMPERATURES.—The temperature of rooms ordinarily is 68

to 72 degrees, and this follows closely for the entire hospital. As in all other systems of heating, the calculation for the entire work should be based on the difference between these inside temperatures and the outside temperatures. There should be sufficient radiation and boiler capacity so that when the outside temperature is 10 degrees below zero and with a given pressure at the boiler, which in the above case should not exceed three pounds, the temperature of the rooms should be maintained with a free circulation in all parts of the apparatus, without noise attending this circulation.

In general the main object in the installation of a steam-heating plant, of whatever pattern or system it may be, is that there be sufficient capacity in all of its parts to insure a quiet and positive service throughout with an attendant economy at the boilers when once the system is installed.

VACUUM HEATING.

Vacuum heating is properly divided into two classes, the mechanical system, which utilizes the waste product of the power plant—i. e., the exhaust system—and the mercury or seal system, which is adapted to the low-pressure heating plant.

The principle of the mechanical vacuum system is to remove the air from the heating apparatus by means of a pump and ejector or similar device. As all resistance is removed, exhaust steam circulates as positively as would steam under pressure. In case there is not sufficient exhaust steam for the purpose of heating, the deficiency is made up by permitting live steam to enter the system through a pressure-reducing valve, which is a part of the apparatus. Pumping the exhaust steam from the cylinder of the engine removes all liability of back pressure. This, together with the fact that exhaust steam was formerly practically a waste product, leaves no doubt that the economical operation of power plants demands a vacuum apparatus. It has truthfully been remarked that a large building using power could be operated at less fuel expense in the winter when the heating apparatus is in use than it could be in the summer when the heat is turned off. This is due to the fact that the engine is relieved entirely of back pressure. Where there is no steam power plant from which exhaust steam may be taken, the low-pressure vacuum system is best adapted, it being evident that the expense of the power necessary to operate the mechanical exhauster, of whatever nature, would equal, if it did not exceed, any saving that could be effected by the use of vacuum apparatus. This fact is generally recognized by manufacturers of mechanical vacuum heating apparatus.

In low-pressure vacuum heating apparatus a gauge is used to indicate results obtained. Most all users of low-pressure steam heating having compression air valves have noted from time to time that after a radiator was heated and the air valve closed that the radiator retained the heat for a considerable time after pressure at the boiler had subsided. Many attempts have been made to perfect an automatic air valve to accomplish this very much desired result, but with poor results. Some of these valves are still on the market. The fact is that a valve for this is, by the nature of the work it is expected to accomplish, subject to constant and rigid wear, with the result that it rapidly deteriorates, and after a short time parts of it must be renewed. This fault, together with the fact that air expelled from a heating apparatus into rooms is very undesirable from a sanitary viewpoint, has led to the revival of a very old method, that of running air pipes from the radiators into the basement, connecting them together and immersing them in a mercury seal.

Vacuum is obtained in this system by first raising pressure to expel the air from the apparatus, the purpose of the seal being to prevent its return. By this means the boiling point of water is lowered, which must be admitted to be a very desirable increase to the range of temperatures at which a steam plant may be operated, especially serviceable in the milder months of early fall and late spring. Actual comparative tests using the same heating plant with and without vacuum attachments have shown a fuel economy, an item worthy of consideration in the operation of even the smallest heating plant. The manner of piping also precludes the possibility of damage to floors or ceilings by leakage, an advantage not to be overlooked.

It must be borne in mind that the above description refers to a tight plant. In ordinary practice a plant that will draw from fifteen to twenty-eight inches of vacuum is easily within the possibilities.

To work perfectly a vacuum system must be perfect in every detail. Thus far, except in a few instances, perfection has not been obtainable, and this only in such measure as to warrant the belief that vacuum heating, except in high-pressure work, will need much study before it can be universally used.

CHAPTER XIX.

IRON.

The use of structural iron and steel in buildings depends wholly upon the design of the building, the system of fireproofing which is to be used, the weight of the loads which come on the floors, and a number of other considerations.

All structural shapes must necessarily be figured out for the loads which they are required to carry. Their general character as to shape, size, weight and length of span all depend upon this one item. If the building has supporting columns, or if it is of the skeleton steel construction—that is, a building entirely of structural steel incased in brick, tile or stone—the sizes of the members of the structure from foundation to roof must be made carefully for that form. If it is of the form as shown in Fig. 1, with all supporting walls, but few structural shapes are necessary. If in such a building reinforced concrete floors were used no structural shapes would be required, as explained under Fireproofing. There are certain structural shapes necessary, however, in all buildings, except those constructed wholly of reinforced concrete.

The following description of such iron and steel work is not intended as a specification guide, but merely to give a comprehensive idea of the use of steel in hospital buildings. Steel for reinforced concrete work is fully explained elsewhere, so that only that for buildings wherein structural shapes are required will be mentioned herein.

The loads to be carried and the usual factors which go to make up the construction of the building would necessarily have to be taken into account for the sizes and shapes of the iron to be used. The manufacture of iron in tensile strength and comprehensive strength are matters which must be left entirely to the engineer. It is only necessary to say that all wrought iron must be of a ductile and fibrous form; that all shapes must be straight and smooth and free from all buckles, blisters, cracks or cinder pockets.

Steel and cast iron also should be of the best quality. The latter should be of the tough gray iron, free from "coal shuts" or "blow holes," and should be up to standard requirements for all of the work.

SETTING.—The setting of all iron and steel work must of necessity be plumb and true, and must be properly secured in position. Ordinarily this is a matter of design, in which each bolt or rivet is shown, but it is well to mention here that unless the work is carefully done there is liability of failure in the structure.

BOLTING AND RIVETING.—All bolt holes in the cast iron should be bored so that the bolts fit securely. The bolts in all of this work should have wrought iron washers, and under all circum-

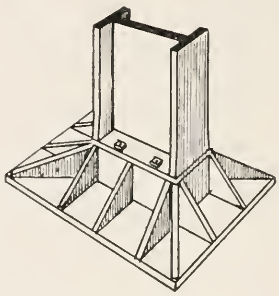


FIG. 202

stances the entire threads on the nuts must be engaged on the bolt. It may be well to mention here that bolts are not as good as rivets for iron and steel work, and their number should be at least 20 per cent. over what would be used if the work was riveted. The rivets should completely fill the holes, and should have full hemispherical heads, concentric with the shanks of the rivets, and wherever practical they should be driven by machine.

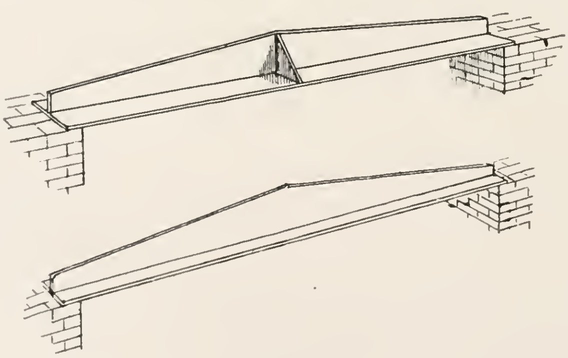


FIG. 203.

BASES.—Bearing beams, girders and the bases of all columns should be solidly bedded in Portland cement. These bases are usually flat plates on the walls, or plates which run with a bevel at the edge and are reinforced, as shown in Fig. 202, for columns. These plates are ordinarily designed and proportioned so that the load on the masonry work upon which they come does not exceed more than three hundred pounds per square inch.

Lintels.—Lintels are of two kinds, the cast iron lintels, some of which are shown in Fig. 203, and the simple form or built-up form of wrought iron or steel, as shown in Fig. 204. These lintels are put over all large openings, or openings with square heads, or those over which loads may come, in order to carry the masonry and those parts of the structure which rest upon or over them.

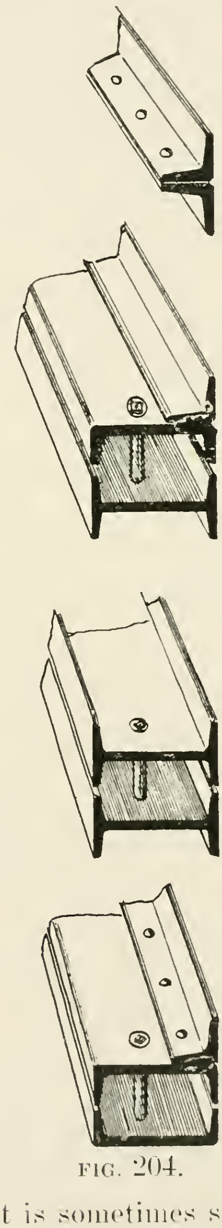


FIG. 204.

In ordinary buildings it is sometimes sufficient to put angle irons over the windows, which will carry whatever may come over them, and to throw an arch on the inside, as shown in Fig. 205. These lintels should all have a bearing on the wall of at least six inches at each end. If they are cast iron, they should under no circum-

stances be less than three-fourths of an inch thick in any of their parts.

Cast Iron Columns.—If cast iron columns are necessary in the building, they should be true and straight, and of a full and uniform thickness for their entire length, and all necessary brackets, flanges and other connections to them should be cast on them, as in ordinary practice bolting such members to cast iron is not to be recommended. All bolt holes in these columns should be drilled. No cast iron column should be less than three-fourths of an inch thick at any point, and they should never exceed in length twenty times their least diameter.

Wrought Iron and Steel Columns.—These should be in lengths of two or three stories, and should be made up of channels

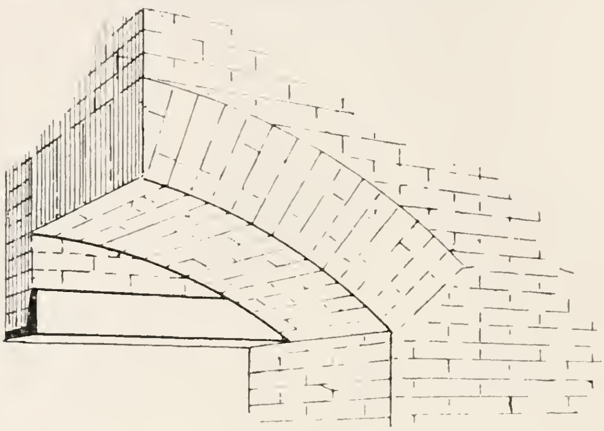


FIG. 205.

and plates so arranged as to form a symmetrical column. Figs. 206, 207 show columns of this kind. The caps and base of these should be built up of plates and angles as shown in Fig. 207. None of these columns should have a length exceeding sixty times its least width. The general design and construction of such columns are left entirely to the engineer.

Beams and Girders in Steel Constructed Buildings.—The floor construction is made up of beams and girders. The girders are the members which run from column to column and catch the beams, the latter being to the building what the ordinary joist is to a wooden constructed floor. The beams should have a bearing of at least eight inches on the walls where they so come, and should be set either on the beams or coped on the beams with what is known as "standard connection angles." Fig. 208 shows the coping of these beams on to the girders.

Box and Plate Girders.—In some instances it is not expedient, and in others not possible, to get beams of sufficient strength to carry the loads which come upon them. In such cases box and

plate girders are built. The box girder is shown in Fig. 209, and a single web rivet girder is shown in Fig. 210. There are so many forms of both of these girders that it would be impossible to ex-

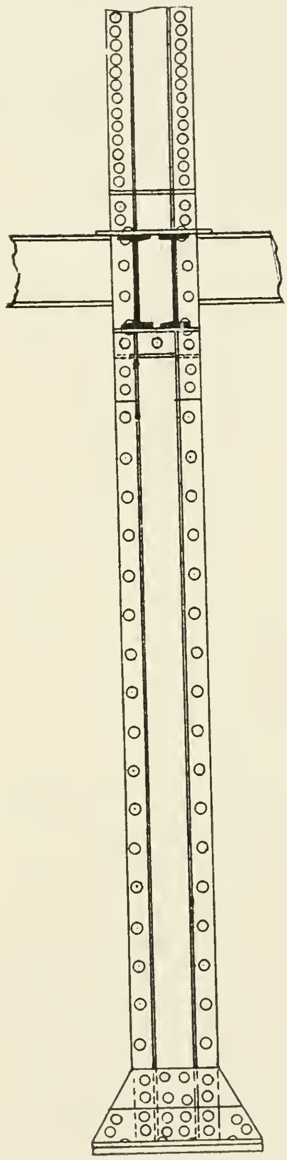


FIG. 206.

plain them all. They are designed in all of their members to carry the loads which come upon them respectively, just as single I beams would carry them.

In box girders there is also provision made for wind stresses, as in this form there is more liability to collapse than in a single beam, owing to the shape of the former.

TRUSSES.—Trusses are ordinarily used in roofs, and are of

several forms, depending entirely upon the slope of the roof, the span, and such other calculations as would come in under built-up forms. They are composed of tension members, which are usually made of iron bars, and compression members which can be one of many forms, but are usually made of angle irons, or such other shapes as would be necessary, depending upon the loads to be carried. From truss to truss there is put what are known as "sway rods," which tie the trusses together, so as to have a continuous strain in any given direction; these rods are so arranged that they are always in tension. Fig. 211 shows a truss with the

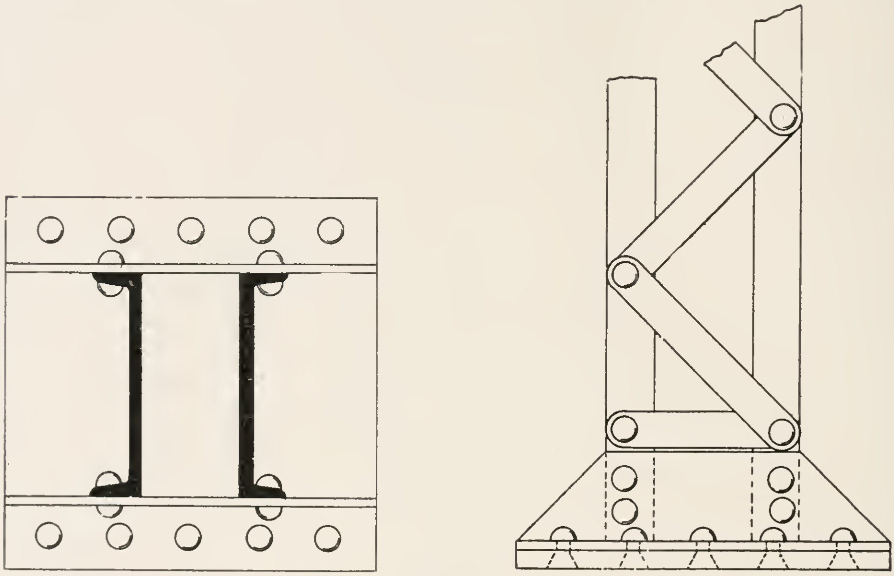


FIG. 207.

Plan. Elevation.

sway rods. These trusses are all built so as to allow for expansion and contraction, which might take place under a difference of temperature. In such instances the trusses are put upon bearing plates, which are bolted to the top of the column, or to the top of the wall upon which the trusses rest.

Purlins.—From truss to truss are then put purlins, which correspond to the ordinary roof joist in ordinary construction. These purlins ordinarily are single angles or T irons.

Fire Escapes.—As mentioned in Fireproofing, fire escapes are of many kinds, and in most instances those which are used in hospital buildings are constructed according to the requirements of the local laws. The two common kinds are the ladder and the stair. There are other forms also, such as the continuous rotary, in which persons are conveyed to the ground by sliding down a circular

chute, and those in which the entire ladder or stairs move, but these will not be considered here.

Fire escapes should be made entirely of wrought iron, and have balconies properly supported, either by brackets or from floor to floor, depending upon the size of these. When balconies are used, they necessarily would be of different construction than if only a platform were provided. The size of the members of

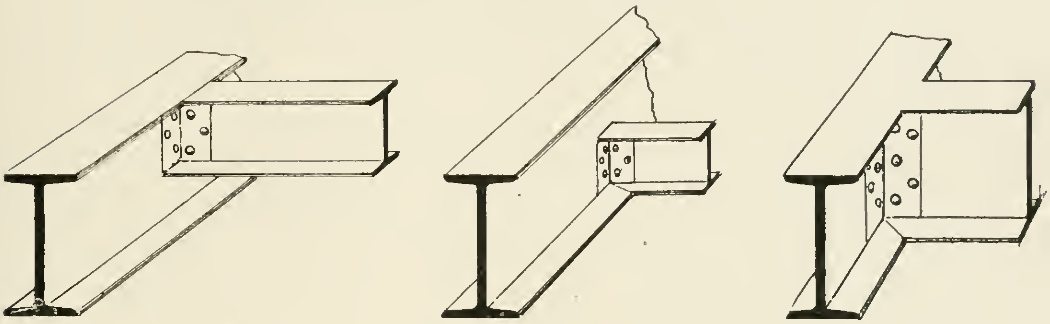


FIG. 208.

these stairs depend entirely upon the design, the length of the runs, and the possible loads which might come upon them.

STAIRS.—In the chapter on Fireproofing mention was made that the stairs are also made of iron, and if so constructed the stringers should not be less than $2\frac{1}{8}$x$\frac{3}{8}$ in. iron placed double, with $1\frac{1}{2}$x$1\frac{1}{2}$x$\frac{1}{2}$ in. lattice bar to support the treads, as shown in Fig. —. The treads are of cast iron and should have checkered top and nosing on the edge, but they may be of the safety tread

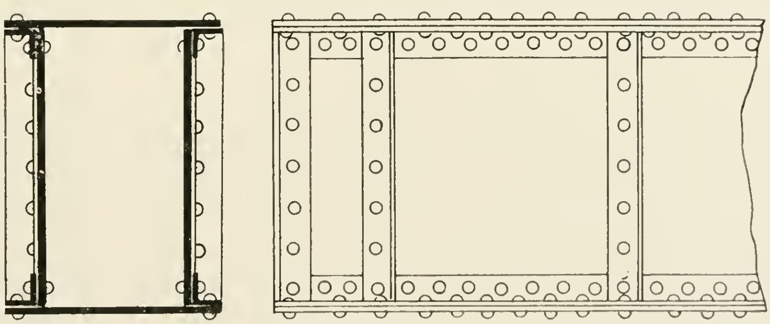


FIG. 209.

type, or, as stated, of some form of marble or stone. The risers may be of the latter, but if the stairs are entirely of iron, the risers are of cast iron with some open work figure.

IRON SHUTTERS.—If iron shutters are used on the windows the frames of these should not be constructed of less than 2x$\frac{3}{8}$ in. iron, and these should be properly covered. The matter of requirements for these is usually stipulated by the local ordinances, or by the rules of underwriters, so that no standard can be given.

The shutter eyes, if such shutters are used, should be built in when the building is being erected.

The iron work for railings, stairways and elevator inclosures usually depends entirely upon the amount of money which is to be expended upon them, and rests largely upon the design desired. These are of the ordinary wire lattice form, the flat steel ribbon form or of built-up wrought iron in round or square bars. They are also made of ornamental cast iron or bronze, but these have no advantage over the simple forms except from an ornamental or artistic standpoint.

PREPARATION OF STEEL FOR PAINTING.

The main requisite for all metal surfaces is their proper preparation for protecting them from corrosion. Nothing in all structural steel work is of more importance than this, unless it be their protection to prevent such corrosion after their preparation. The one is absolutely dependent upon the other, for the best paint is of

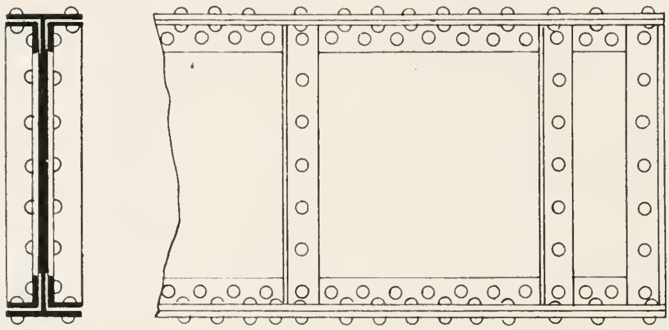


FIG. 210.

little use if the cleaning is improperly done, and, on the other hand, poor paints and poor painting are of no consequence, however clean the surface may be. The following requirements do not apply, however, to surfaces subjected to great heat. They must be treated in a wholly different manner.

Mill Scale.—These small scales of iron formed by the rolling of the shapes while hot from the ingots must be thoroughly removed. Rust, dirt, grease and the other extraneous substances on the surfaces must also be removed. This is done with wire brushes, sand blast, scrapers, benzine, etc., or in case there is more than fine surface rust, such rusty parts must first be subjected to the flame of a torch, until the oxide has been entirely converted. In using brushes for removing scale and rust, no larger than a No. 6 brush should be used, and under no circumstances should the use of flat brushes be allowed.

After the cleaning is complete the priming or shop coat should

be applied at once. The steel should not be allowed to stand. The paint should be applied thoroughly and no painting should be done by machine. The paint should be applied in a smooth and even coat, and care taken that all joints and crevices are properly covered. In all work of a compound nature—namely, where shapes are put together, as also all drilled holes, permanent bolts and riveted work, such work should be first primed, and this coat left to thoroughly dry before the members are assembled or put together.

If any abrasion of the prime coat occurs in the handling, loading and erecting of the work, such abrasions must be thoroughly recoated and left to stand for at least four days before the final or field coat of paint is applied. If any rust should form at these abrasions, it must be thoroughly removed before the priming is done.

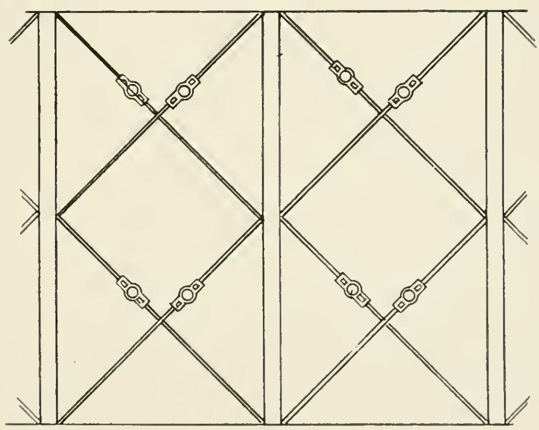


FIG. 211.

Not too much stress can be laid on the foregoing, for it is, as stated, of vital importance in the protection of the structural steel from corrosion.

When the steel is riveted the entire work should be given two good coats of paint, or, better still, three good coats. Each coat of paint should be allowed to stand for at least four days, until it is perfectly dry, before the next coat is applied. The same care in applying each coat must be exercised as was given to the priming or shop coat.

There will be points in the work where deep crevices and recesses are formed. These should be filled with Portland cement and allowed to become thoroughly dry before the field coats of paint are applied to them. It would be well to treat such cement with a waterproofing compound, such as was mentioned in the chapter on Concrete. This work must be done carefully and thor-

oughly, as these crevices and deep recesses are the points which would admit or retain water.

No painting should be done on wet or frosty surfaces, nor in a temperature lower than 32 degrees F. All priming should be done under cover, and no retouching done until the steel is erected, unless it can be done immediately upon arrival of the steel at the building. Abrasions caused by erection should be primed immediately after the steel is in permanent position. The painting of steel should in all instances be done with materials which contain no artificial, so-called boiled linseed oils, drying oils, japans, driers and naphtha, as all of these are injurious to the paints and deteriorate rapidly.

Painting of Steel.—There are many so-called preservative paints for the treatment of steel, and the utmost care must be taken that these are perfectly adapted to this class of work before they are used.

Paints for steel and iron are of two kinds—those in which pigments of one kind or another are ground into linseed oil, and the so-called chemical paints which are in the nature of carbon products chemically treated.

There always has been, and probably always will be, a vast difference of opinion as to the best method and best paints to use for the protection of metal. This may be due in part to the fact that under various conditions the same paint will at different times show different results. The direct consequence of this, irrespective of individual opinion, has been the manufacture of different kinds of paints, with different ingredients and different methods of mixing these. It is safe, therefore, to use only such products as have been found to give the greatest satisfaction and best results in the largest number of instances. It is the object, therefore, of this section to explain the different kinds of paints as concisely as possible, giving them in the order of the results obtained rather than in the order of preference. The paints are as follows:

I. Those made of pure graphite and boiled linseed oil.

II. Those of pure graphite with other inert materials and linseed oil.

III. Carbon paints.

IV. Paints for resisting acids, gases and the fumes of these.

V. Paints on surfaces subjected to great heat.

VI. Those with a graphite base, but made in colors.

VII. Paints with a red lead color, but containing only a small percentage of red lead.

VIII. Red lead.

The Fallacy of "Thick Coat" Painting.—Certain engineers, from a theoretical standpoint, have considered a thick coat essential to good painting. The contrary is the truth, as borne out in practice. The more a coat of paint is brushed out and properly covers the surface the better will be the results of drying, and the more fit will that coat be to receive and hold succeeding coats. A thick paint film will of necessity cause trouble to itself and to succeeding coats, which will not become thoroughly knit together, will not form a homogeneous coating, and with the contraction and expansion of metal are bound to crack badly. This is true whether the thick coat results from the "flowing on" of a paint capable of better spreading or from a paint of poor opacity that can only cover by using a heavy coat. If the paint has the proper opacity and can be thoroughly brushed out for the first coat and brushed into the surface, it will get a firmer hold on it, fill its pores better and make a more satisfactory protection to the metal as well as a better foundation for the coats to follow.

The first requisite of all paints of the pigment variety for the proper protection of metal surfaces is that these be made of properly treated linseed oil and the combination of the pigments with this. The linseed oil must be pure, thoroughly so, in fact, and not in name only. It must contain no albumen, mucilaginous matter and other perishable constituents, as these ingredients are harmful and hasten decay when left in the oil. Linseed oil with these deleterious substances removed is increased in its drying qualities, and makes it possible to eliminate driers and japans which are harmful to paint. All linseed oil should be thoroughly aged, as the ordinary method of filtration will not give the quality to the paint that aging does. All paints should be machine mixed. Paint in paste form cannot be mixed by hand as thoroughly as it can be done by machine.

1. Graphite paint, as its name implies, is made from graphite pigment. The natural graphite paint contains only from 15 to 60 per cent. of the pigment. The best form is graphite produced in an electrical furnace, and is superior to the graphite which is found in nature in one of two forms—the flake and the amorphous. The flake graphite does not make a good paint on account of its flake or splinter-like structure, which prevents it from combining thoroughly with the oil when put on the surfaces of metal. The amorphous form, while it can be finely ground, is found with such a vast number of impurities mixed in with it, such as silica, clay and other foreign matters, that it has little value as a pigment for paints. Both of these natural graphites preclude the possibility of uniformity in the paint. The artificially produced

graphite can be ground to an impalpable powder and is so finely divided that it mixes readily with the linseed oil, forming an even, homogeneous coating when applied and makes a 95 per cent. pure graphite paint.

Pure graphite paints are never colored. Natural graphite is a dull black, and any coloring matter which is put into it must be a very large proportion of the paint. Red oxide, chrome yellow or other colors materially displace the graphite, thus lessening the protective value of the paint.

2. Paints of this character—namely, those which contain pure graphite with other inert materials well mixed in linseed oil—should contain about 60 per cent. of pure graphite, and of the remainder the principal part should be silica. This proportion would then contain about the same amount of graphite as is used in the best natural graphite paints. Under such circumstances this paint has many of the good qualities of pure graphite, being largely composed of the same pigments. The real difference in the paint is in the more rapid drying qualities of this form.

It is made primarily to meet special conditions—namely, that there must be rapid drying with a hard surface. It is this latter quality—the rapid and harder drying—which sacrifices to some extent the durability of the paint, but it is not of such great importance that it need be considered seriously. Driers are necessarily put into this paint, but if they contain no gums and are made on a linseed oil base, there is no deleterious effect on the surface of the metal. It may be said in connection with this form of metal paint that where there is liability to abrasion it is superior to the softer, slower drying pure graphite paint. Owing to the fact that this paint is not a pure graphite, it can also be made in gray.

3. The so-called "carbon paints" are ordinarily chemical, inert, metal protectors made on a charcoal base; the charcoal is in a powder pigment form.

4. The non-corrodible, acid-resisting paints are chemical combinations for the protection of metal surfaces subjected to the corrosive action of gases, acids or their fumes. It is also a protection against salt water.

5. The fact that graphite paint is not adaptable under any circumstance where the metal surface is to be subjected to heat has given rise to the need of a protective paint for such purposes. While such paints do not ordinarily pertain to iron construction, they are nevertheless used to some extent in the painting of pipes, boiler fronts and smoke stacks. They are made so that they will stand extreme heat without blistering, scaling or cracking.

6. Owing to the fact that there has been a doubt at times as to the proper application of the pigment, and the specified number of coats of this which should be put on iron, the subject of a paint with a graphite base to be made in different colors naturally arose. It is absolutely impossible, however, to produce red, gray, green and other variations from the dull black, without combining some coloring matter, such as iron oxides, chrome yellow, etc., as mentioned, which cannot fail to weaken the protective character of the pigment. As can be readily seen, it would require a very large percentage of coloring matter to turn the black into a red, gray or green. The use of such paints is not recommended.

7. Paints with red lead color are a substitute for pure red lead of the same color. They contain a much smaller percentage of red lead and for that reason do not have the high oxidizing qualities that the pure red lead possesses. For this reason alone they are to be recommended rather than the latter. The fact that such paint has a lighter specific gravity than the pure red lead prevents a rapid settling and hardening, and counteracts the tendency to crawl and run, both of which are such great drawbacks to the use of pure red lead.

8. The use of red lead as a protective paint for metal surfaces has been steadily decreasing, as the efficiency of other materials for this purpose have become better known. Probably the use of this material at the present time is due to the fact that it has been employed for so many years that engineers are prone to follow the precedent rather than look into the merits of other protective paints. The main objection to red lead for general use as a metal paint lies in its high oxidizing qualities, which soon burns up the oil and attacks the iron and steel. The use of red lead instead of preventing corrosion would, under these circumstances, produce it. Red lead is made under conditions which permit great quantities of oxygen to be given up to it by air, and as its symbol Pb_3O_4 would indicate, is extremely rich in oxygen.

An example of its extremely quick oxidizing properties, and the reason for its being a poor metal paint, is shown in the fact that when it is mixed with boiled linseed oil, or quick drying oil, by adding two or three pounds to 100 pounds of raw linseed oil and heating them, it is utilized to make what is known as rust joints in iron pipe work. The red lead is smeared on the screw threads of the two pieces of pipe to be joined together; the oxygen in the lead attacks and rusts the iron forming a permanent joint that in most cases cannot be unscrewed. This in itself would show how impractical it is for use as a protective paint.

There are other objections to it if used in a pure state—namely, that the cost of the material and the cost of application is far in advance of paints which are better adapted. It is difficult to apply because it dries so rapidly and settles hard in the package; it is hard to brush out so as to satisfactorily cover joints, seams, and bolt heads; it streaks badly on account of its coarseness and high specific gravity; the pigments separate from the oil and leave the coat thick in one place and thin in another. The matter of settling hard and the fineness of the pigment can be somewhat rectified by proper machine mixing, but even under these circumstances it must be made up immediately before it is used, so as to prevent the settling out and hardening of the pigment.

CHAPTER XX.

ROOFING AND SHEET METAL WORK.

ROOFING.

There are several methods of roofing buildings, dependent largely upon the construction of the building itself. Inasmuch as smaller hospitals will probably be built of ordinary construction for some time to come, all methods are explained for each kind of building.

Roofing may be done in the following manner:

First—The so-called composition roof, with its multitude of methods.

Second—Tin or metal roofs, which are also of several kinds.

Third—Waterproofing, which applies to flat roofs on fireproof buildings.

Besides these there are the ordinary shingle roof with its variation in the manner in which the shingles are laid; the slate roof; and the tile roof. To these may be added the ready-made roofs, or, as they are ordinarily designated, prepared roofing, of which there are many kinds. The last named are used, however, in some forms under the third class—namely, waterproofing.

The composition roof consists of laying tarred felt or asphalt felt, as shown in Fig. 212, and is used only on flat roofs. The number of times the first sheet overlaps the last sheet is designated as a "ply," so that we may have three, four, five, six, etc., ply roofs. The manner of laying such a roof is as follows: Over a wooden deck or roof, the entire roof is first covered with a dry felt or rosin sized sheathing paper—namely, one that has not been tarred. This is done so as to prevent any of the tar or asphalt from coming through, owing to the softening under the heat of the sun, and from staining the ceiling of the top floor, and also to protect the main body of the roofing from breaks owing to shrinkage of roof boards. Over this is ordinarily laid a five-ply tar pitch, or asphalt, felt, or slag or gravel roof.

Felt.—The felt should not weigh less than fifteen pounds to the hundred square feet, known as a "square," single thickness.

Pitch.—This should be of the best quality straight run coal tar, distilled direct from coal tar. There should be no less than

one hundred and twenty pounds of this for each square of one hundred square feet of completed roof. The nailing should be done with three-penny barbed wire roofing nails driven through tin discs.

Gravel.—The slag or gravel should be of such a grade that no particles are more than five-eighths inch, or less than one-fourth

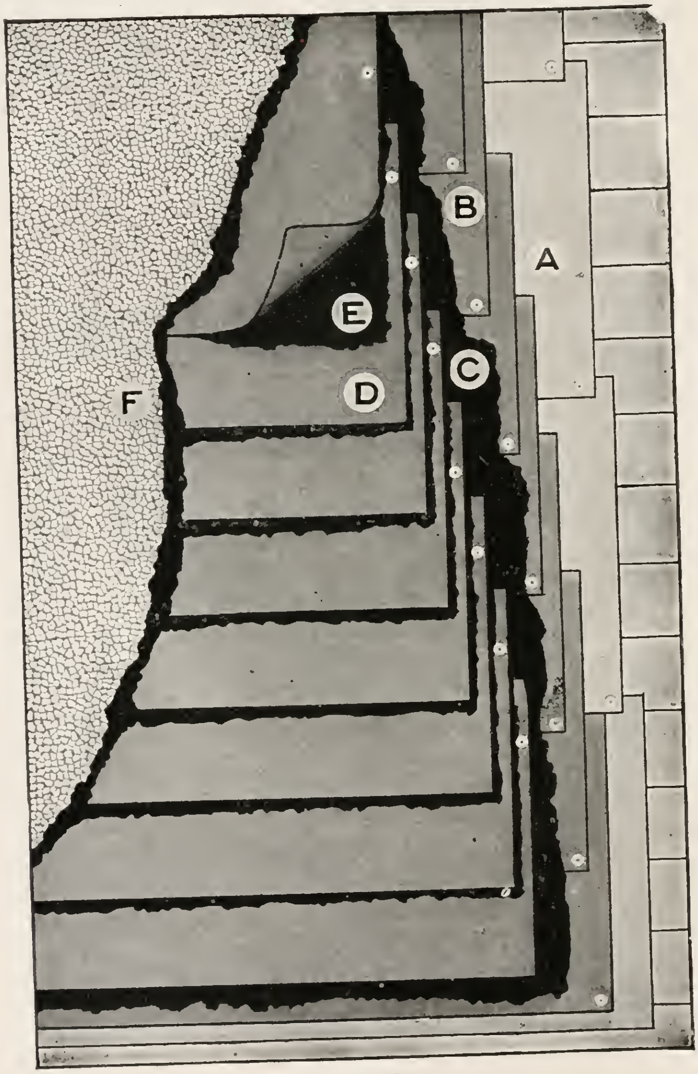


FIG. 212.

inch in size. It must be dry and perfectly free from all dust, dirt or other foreign matter. When this gravel is put on in cold weather it should be well heated just before it is applied, and there should be not less than three hundred pounds of slag, or four hundred pounds of gravel, used on each square of one hundred square feet of finished roof.

These materials should be applied in the following manner:

The felt shown at (A) in the illustration must be carefully laid with a lap of at least one inch, and if possible three inches over the preceding sheet, and nailed only sufficiently to hold in place until the tarred felt is laid. It is preferable to use no nails in this. Over this dry sheet should be laid two thicknesses of the tarred felt (B), lapping each sheet seventeen inches over the preceding one, and mopping back with pitch the full width of each lap, as shown in Fig. 212. Over the felt thus laid there is spread a uniform coat of pitch (C), carefully mopped on. On this coating is put three full thicknesses of the felt (D), lapping each sheet twenty-

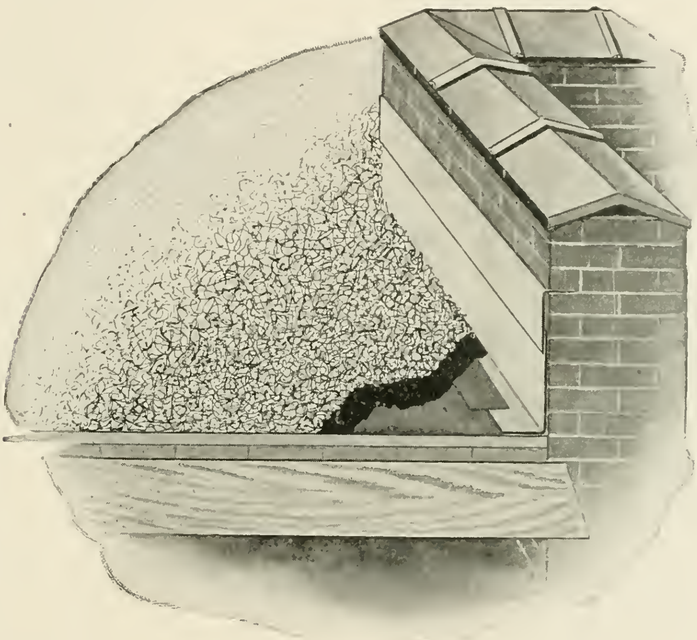


FIG. 213.

two inches over the preceding one and nailing, as laid, every three feet, not more than nine inches from the upper edge. This, as shown, would make a three-ply layer over the preceding two-ply layer. As in the case of the latter, the full twenty inches of the three-ply layer must be mopped back with the pitch. The entire roof is then spread over with a uniform coating of pitch (E), into which, while hot, in cold weather, is embedded the slag or gravel. If a "cap sheet" is put on, this must be laid over the roof while the even coating is wet, lapping at least three inches, and then mopped evenly with a coating of the pitch and the gravel or slag imbedded in this while hot.

The roof felt must be brought well upon the walls and all other projections and thoroughly mopped and fastened. The walls can be flashed and counter-flashed with galvanized iron, tin or

copper, as shown in Figs. 213, 214. These flashings are cemented into the brick or stone courses, as shown, with slaters' cement. A roof such as described could also be put over a cement or tile roof on fireproof buildings, if these are flat with the ordinary fall of from one-half to one inch to a foot toward the gutter. The roof could not, however, be used on a slanting or hip roof, owing to the pliability of the material and its tendency to run under the heat of the sun.

TIN ROOF.—Tin is used on either the flat or sloping roofs. Roofs with less than one-third pitch are made with flat seams. Tin

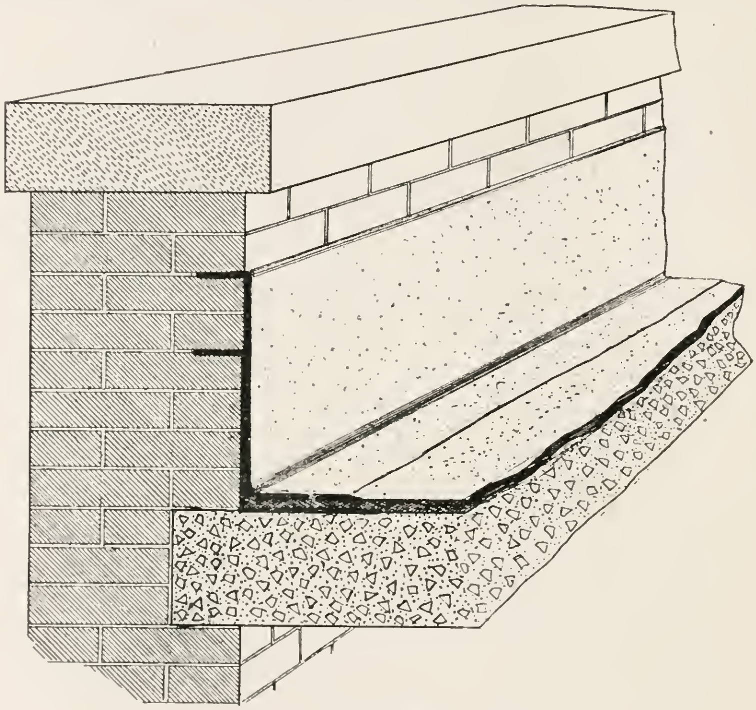


FIG. 214.

comes in sheets from 14x20 inches dimension to 20x28 inches. The smaller size, 14x20 inches, should be used on all flat roofs, because the larger number of seams stiffen the surface and help to prevent buckles and rattling in stormy weather. For flat seam roof one inch barbed and tinned roofing nails should be used, not over six inches apart, well under the edge. They should be well covered up and the seams should be pounded down over the edge with a wooden mallet. Nails must never be exposed. The seams should be made with great care; and sufficient time must be taken to properly "sweat" the solder into the seams.

Steep tin roofs should be made with standing seams and from sheets 20x28 inches. The sheets are first double seamed and soldered together into long strips that reach from eaves to ridge. The

sloping seams are composed of two "upstands," interlocked and held in place by cleats. The standing seams are not soldered, but are simply locked together with the cleats folded in from 15 to 18 inches apart. Nails should be driven into the cleats only.

While it is always cheapest to use the best material, roofing plates with a lesser coating may be used for steep standing seam roofs. Roofing plates in which the iron body weighs 50 pounds per 100 square feet are more suitable than plates 62½ pounds per 100 square feet, because the seams in the lighter plates will not suffer as much from contraction and expansion as the thicker plates. The amount of terne coating on the lighter sheets should in all cases be fully as heavy as on the heavier plates.

In late years the anxiety of some manufacturers to satisfy the demand of the people for cheap goods has resulted in the introduction of many inferior grades of roofing.

This latter class of material may suit for some purposes outside of roofing, or for roofs on temporary buildings, but for roofs that are expected to last, the "double dipped" and "extra coated" plates should be adopted.

The use of acid in soldering seams in a tin roof is to be carefully avoided; acid coming in contact with the bare iron on the cut edges and corners where the sheets are folded and seamed together will cause rusting. No other soldering flux but good rosin should be used and all acid spots and deleterious substances should be removed as the tinner's work is being finished. Lumps of rosin left on the roof will melt in the sun, stick to the roof, cause blisters and prevent paint from adhering.

For valleys, spouts and gutters of a tin roof, no other metal than terne plates should be employed, because the galvanic action produced by different metals coming in contact with each other will cause disintegration under atmospheric influences.

The sheeting boards underlying the roofing tin should be put close together.

The wood should be well seasoned, dry, and all knots should be culled out. It is also advisable to cover the boards with good building paper before the tin is laid on. Care should also be used in the quality of paper placed under the tin. Where paper is used it should not be anything that will technically answer for paper, but a good waterproof one that will not absorb the dampness, dry at once, and protect the tin from gases and dampness underneath. The paper serves to exclude from the tin injurious vapors, gases or fumes that continually rise from the rooms below. When no paper is used, the tin must in all cases be painted on the under side with good reliable paint before it is laid and fas-

tened on the roof. The outside should receive the paint as soon as the roof is finished (see Painting under Chapter on Iron). To make tin roofs last they should be repainted every two or three years with good paint. The frequency of the intervals will depend largely on the climatic conditions of the country.

TILE, SLATE AND SHINGLE ROOFS.

Ornamental Tile.—Slate and shingles are used only on sloping roofs—that is, those with gables or when the roof slopes on all sides to a point or a ridge—on dormers and turrets and on ornamental portions of the building above the roof. The slope of such roofs should never be less than 30 degrees from the horizontal and should have more angle for the tile than for the slate. The method of putting on these roofs follows practically the same lines. The shingle roofs need no special mention, except that they are not advocated for hospitals. Tin or slate roofs are preferable

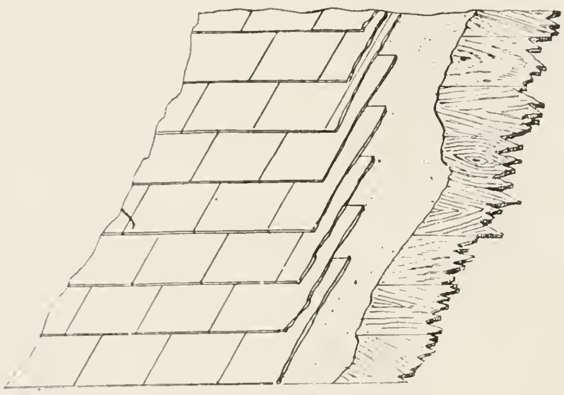


FIG. 215.

as they are fireproof, and even if the hospital is of ordinary construction instead of fireproof, it will somewhat protect the building from flying sparks should a fire occur in the vicinity. Moreover, shingles are not economical, as the best shingle roof, well creosoted to preserve the shingles, will not last for more than ten years, and in most climates rarely that length of time. A slate roof will last as long as the building stands, and with proper care a good tin roof will last as long as a slate roof.

Tile roofs and slate roofs are used only on sloping surfaces, as all of the space in hospitals is of value, and ornamental roofs with attics under them are not recommended. As mentioned herein, the added expense of such roofs could be better applied elsewhere in the hospital. If such roofs are used the following will be of assistance:

Slate should be of the unfading variety and put on in plates of about eight inches by sixteen inches, with all proper flashings

and counter-flashings, as described herein. All slate should be punched to receive the nails, and each slate fastened by at least two copper or copper-coated nails. Slate should be laid with a lap of three inches of the third slate over the first row, as shown in Fig. 215. All hips and ridges on the roof should have the slate doubled and laid in slater's cement. Under all slate there should be two thicknesses of dry waterproof sheathing felt or paper.

Tile roofs are laid according to the tile used. If shingle tile are used, they are laid just as slate is, except that at the ridges either a flat or ornamental ridge mold is put on. The ornamental types of tile are all made so that they fit and overlap in specially prepared grooves and slots, with corresponding raised portions and drips to fit into these. This is done both on top and bottom and on edges. The ridges and hips of the roofs are all put on in ornamental tile with finials, etc., as required by the design of the building with such roofs.

Prepared Roofing.—There are many varieties on the market and they need no special mention here. They are prepared of rubber compounds, tar, asphalt and other materials, each having its own merits. These roofing materials come in large rolls and are laid on the roof with a slight overlap at the joining made for this purpose and are cemented at these joints. Nails with tin washers are driven into these overlaps and cemented over.

WATERPROOFING.

Waterproofing as applied to roofs may be done in several ways. The tile or concrete, as the case may be, should be perfectly smooth and graded to carry the water to the outlet or gutters. Over such a roof should be laid a five-ply cold tar pitch, felt and slag, or gravel roof, which should be constructed as follows:

Felt.—The felt should not weigh less than 15 pounds per 100 square feet, single thickness.

Pitch.—The pitch should be the best quality of straight run cold tar pitch, distilled direct from the American coal tar, and there should not be less than 200 pounds of this used for each 100 square feet or one square of completed roof.

Gravel.—The slag or gravel should be the same as for roofs over sheathing boards as described herein, and there should not be less than 300 pounds of slag, or 400 pounds of gravel, used on each 100 square feet or one square of the roof.

These materials should be applied as follows: The concrete or tile should be coated with hot pitch (B), which should be mopped on uniformly. Over this coating of pitch there should be laid two thicknesses of the tarred felt (C), lapping each sheet

seventeen inches over the preceding one and mopping back with pitch (D), the full width of each lap. On the felt thus laid there should be spread a uniform coating of pitch (E), thoroughly mopped on. Over this then should be laid three full thicknesses of the felt (F), lapping each sheet twenty-two inches over the preceding one. When the felt is thus laid it should be mopped back

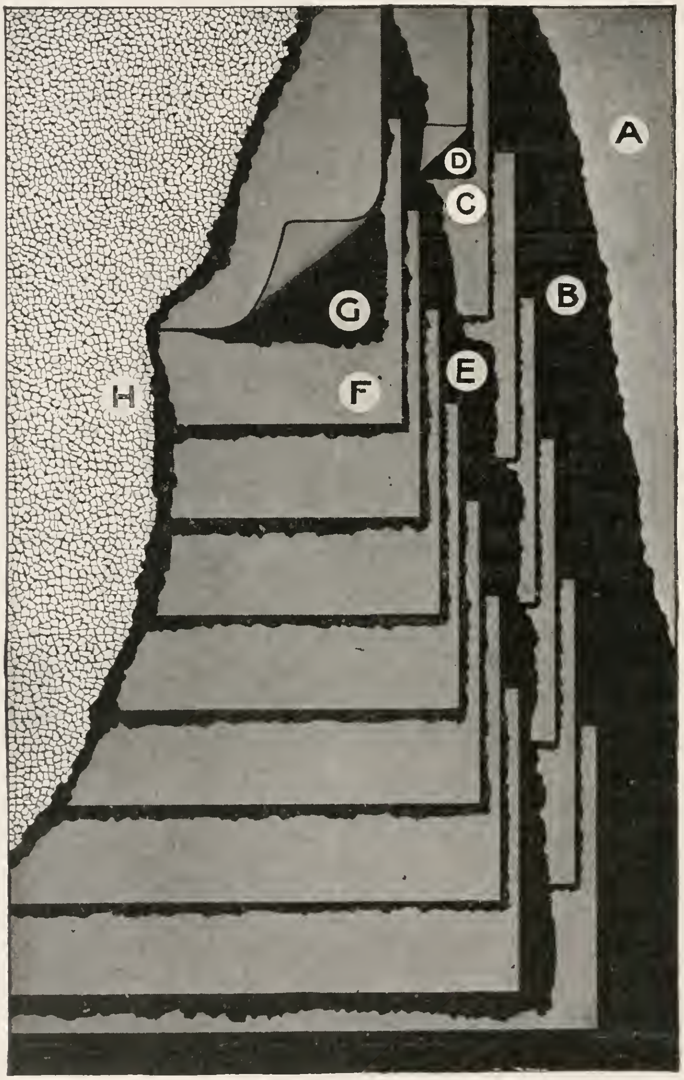


FIG. 216.

with pitch (G), the full width of the twenty-two inches under each lap. Over this entire surface a uniform coating of pitch should be put on, into which, while hot, should be embedded the slag or gravel (H). A cap sheet can be put over the entire roof as shown, but this is not necessary.

Such roofs can also be applied in six-ply and cap sheet, and

seven-ply and cap sheet, but their wearing quality is no better than the five-ply and cap sheet roofs, if put on properly and carefully.

Roofs can also be waterproofed in the same manner as are walks or basement floors. In this method the waterproofing is placed over the tile or concrete and a finished roof of cement or tile put over this. When done in this manner the waterproofing must be applied with extreme care, and when so done makes prac-

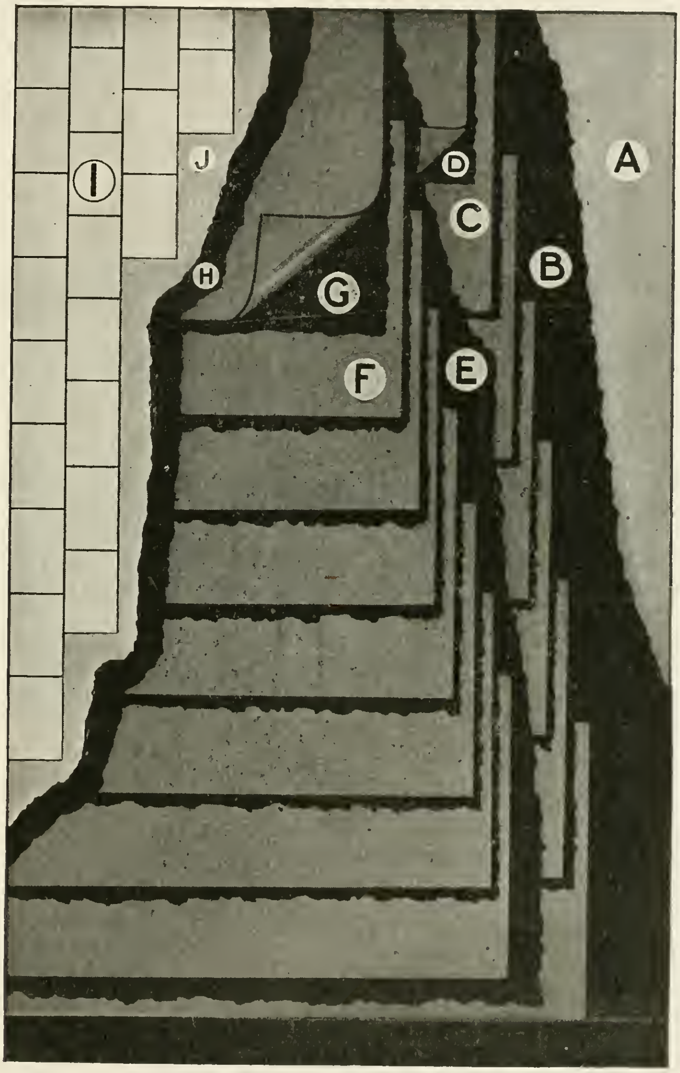


FIG. 217.

tically an indestructible roof. Such a roof can be used for a multitude of purposes. Walking on it does not injure it, inasmuch as it is practically a cement floor. The cement top dressing should be treated with one of the compounds used for making cement waterproof. The waterproofing can be done as follows:

The felt and pitch are the same as for the roof just described;

the materials to be used as follows: The concrete or tile at A is coated with hot pitch (B), and the same roof put on as described above for roof over concrete. After the top surface is uniformly mopped with the hot pitch the entire roof is finished with either a cement top dressing about $1\frac{1}{2}$ to 2 inches thick, or is laid with a course of vitrified plate tiles (I), 6x9x1, laid in and thoroughly grouted with Portland cement mortar (J). The same general specification applies where brick or composition tile are used instead of the vitrified plate tile. In putting a roof on of this char-

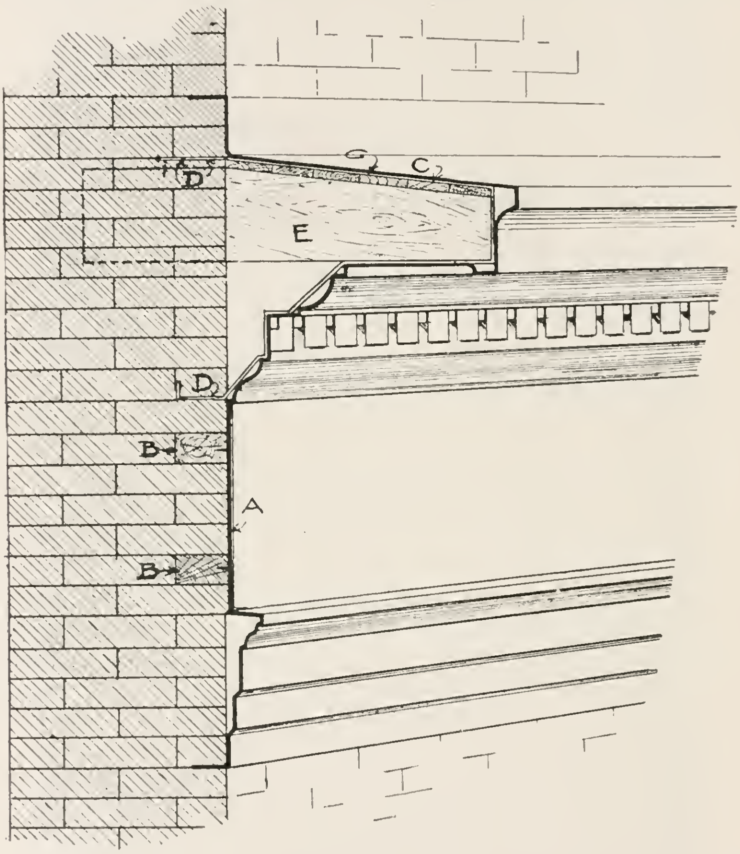


FIG. 218.

acter, it is necessary to flash and counter-flash with tin, galvanized iron, or copper, as shown in Fig. 214.

Sheet Metal Work.—Under the heading of sheet metal comes the construction of all such parts of the building as are made of galvanized iron, copper and tin, except roofs and ventilating flues.

Galvanized Iron.—The galvanized iron work includes the skylights and vents; covering of outside work when constructed of wood; cornices not made of copper or other materials, down spouts or rain leaders, and all gutters, where these are not made

of tin or copper. Flashings are also made of this material, but can be made of copper or tin.

CORNICE.—Cornices are made ordinarily of twenty-two to twenty-six gauge iron with joints riveted every two inches and then soldered tightly. The cornice is fastened to the building with stays, as shown in Fig. 218. These stays should be made of $\frac{1}{4}$x$1\frac{1}{2}$-inch iron, securely riveted to the galvanized iron every two feet, and these stays anchored into the wall, as shown at A. If a frieze is put on the cornice of galvanized iron shown at A in the illustration, it should be of crimped iron, as the large straight surface is liable to buckle and get out of shape, while the crimps reinforce and stiffen the whole surface. Blocks should be built in the wall to receive this frieze, so that it can be securely fastened in its entire length. These are shown in the illustration at B. The deck or top of the cornice must be put upon a boarded deck or platform, as shown at C. This platform is built on lookouts, which are placed about two feet apart and are shown at E. These lookouts or brackets are also built into the walls which run behind the cornice, and are usually shaped to admit the crown or top

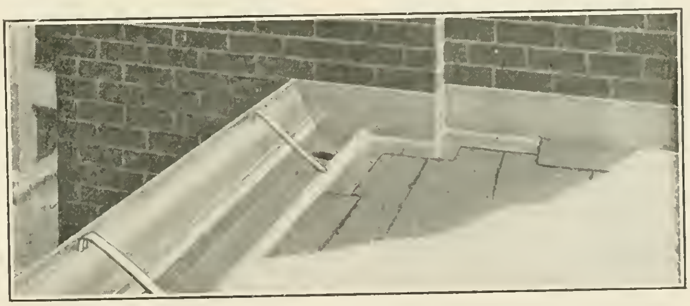


FIG. 219.

members of the cornice. Brackets on cornices are usually stamped and are soldered on if the design of the cornice is made with such ornamental features.

GUTTERS.—Gutters are sometimes run in the main cornice of the building, but more often independently of this. This depends, however, upon the design of such roofs. If the roof is sloping, the gutter preferably would be in the cornice, although on flat roofs they are rarely placed there. Gutters are made of 22-gauge galvanized iron and are fastened with hooks and stays, as shown in Fig. 219, in which A shows the hook and B the stay. The iron is well flashed under the roof as shown. The gutter slopes not less than one-half inch to the foot to the downspout, with a strainer at the lower end to prevent foreign matter from clogging up the spouts. Gutters often take the form of a leader head, which is shaped somewhat like a large deep pan. If such heads are used,

their sides must be carefully calculated so that they will be sufficiently large to contain the water which runs into them. They are usually placed where a continuous gutter cannot be used, and the entire water of a large roof discharges into one or two of them, consequently they act somewhat as an overflow reservoir. Gutters can be made ornamental and overflow heads can be made in a multitude of designs.

Downspouts.—A sufficient number of these must be supplied to carry off the water easily. They should never be less than six inches in diameter, unless there are great numbers of them; they can be of square or rectangular pattern, but of whatever shape they should always be made in the expansion pattern, as shown

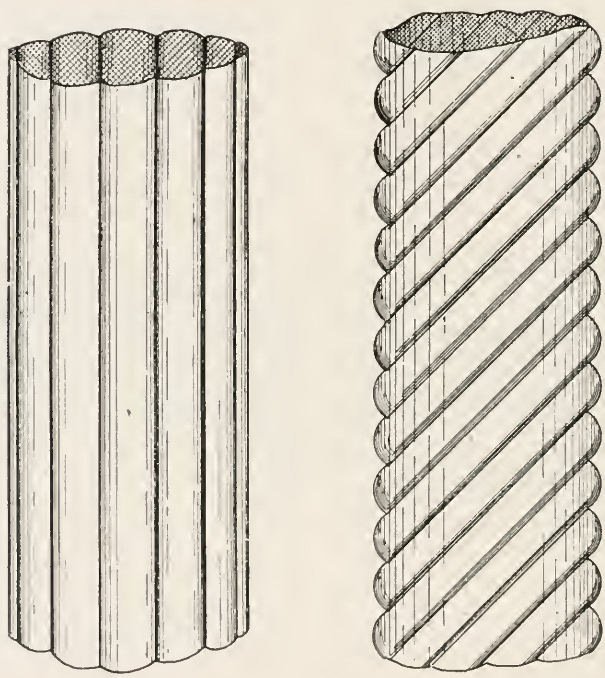


FIG. 220.

in Figs. 220, 221. They are made in this form to permit of expansion in case of freezing. Downspouts can also be made ornamental with ornamental heads and stays. All downspouts run continuously from the gutter to the sewer stub. It is well to have the lower three to five feet of cast iron, to prevent their destruction by heavy objects coming forcibly in contact with them. The iron foot pieces can be ornamentally cast, or can be heavy cast iron soil pipe, depending upon their location. All downspouts should be securely fastened to the walls, at least every four feet in their entire length, with galvanized iron hooks, as shown in illustration. These are made plain or ornamental as occasion requires. Downspouts are

made of cast or wrought iron pipe in some cases, but in such instances they are usually run inside the building.

Flashings.—Flashings are put on the roof, as shown in Fig. 213, 214, and are ordinarily run up on the wall at least eight inches and cemented into the course between the brick, or in slots cut for the purpose in stone. Counter-flashings are sometimes put on, as shown, the metal being put over the flashing in the same manner as the flashing is fastened and cemented into the wall. These counter-flashings are brought down to the roof level and bent out

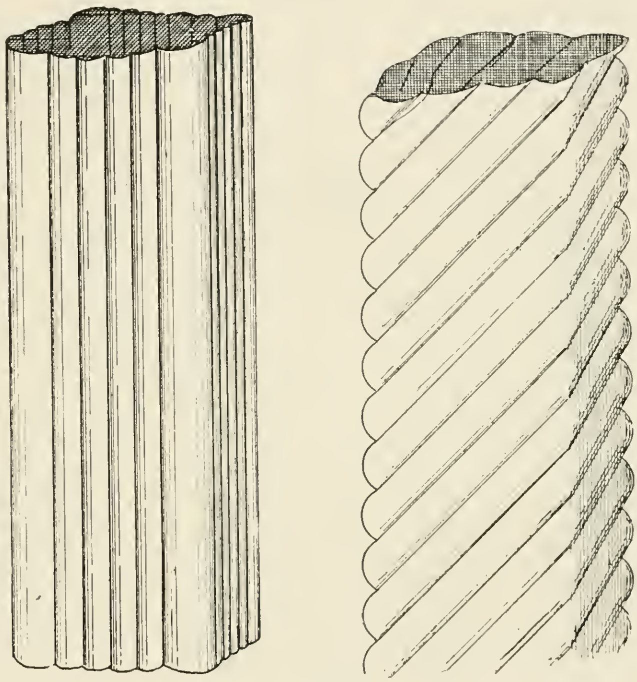


FIG. 221.

with a drip. Flashings are also used under shingle, tile or slate roofs in the valleys. These flashings should extend under the tile on either side at least eight inches. On sloping roofs, cornices, when of metal, and gutters are flashed under the roofs, as are also the gutters on flat roofs.

Vents.—Vents on skylights and those over the sterilizing apparatus can be of several patterns. Figs. 222, 223 show two forms of vents. Those over the sterilizing rooms should be of large diameter, start at the ceiling line and run continuously at least two feet above the roof. There should be two vents on each skylight, their size depending upon the size of the room underneath. These vents, however, should not be employed when those as described in Ventilating are used. Where necessary such vents should have a valve and a cord to operate them.

Skylights.—Skylights should be so constructed that they will exclude all condensation. In hospitals all skylights should face north only—the sides and top being built of tile, concrete or wood, as the case may be. In the last named form the sides and top are covered with galvanized iron, or the top is roofed as described under Roofing. The skylight should be made double in all of its parts, as shown in Figs. 64 and 88. Such skylights will exclude all condensation. As shown in these figures, the outer glass is removable to permit of cleaning both sets of glass. This can be done by

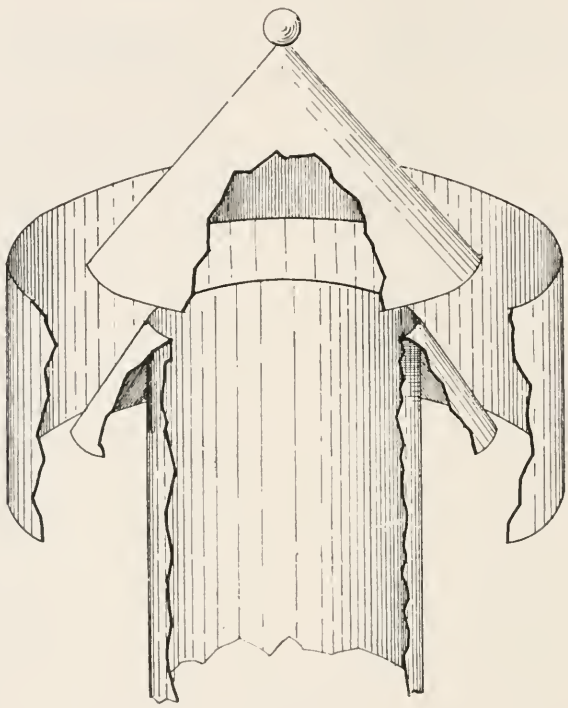


FIG. 222.

setting the wire glass in angle iron doors, the inside lights being clear plate.

This method of putting in double glass is superior to that of the single skylight glass, and the so-called ceiling lights. In the latter form of skylight there are two methods of putting in such ceiling lights—first, supporting them in a loose iron frame, or a hinged-iron frame, so that the whole light can be lowered for cleaning. This has the decided disadvantage of not being dust-proof, and being extremely heavy to handle for the frequent cleanings which would be necessary in a light which lies horizontal. The second method is that of putting a dust-proof, air-tight light at the ceiling; in other words, of permanently cementing such a light into place. If this is done it is necessary to have attic space above this sufficient to permit of one or more doors being put into

the walls of the skylight duct. Inasmuch as it is impossible to get the outer lights of a skylight absolutely air-tight, this ceiling light is subject to fine particles falling upon it, and so obscuring the light and making it necessary to clean it. It is difficult to do this if the light or lights are of any extent, as it is impossible to get over them without special apparatus for the purpose. The frame can-

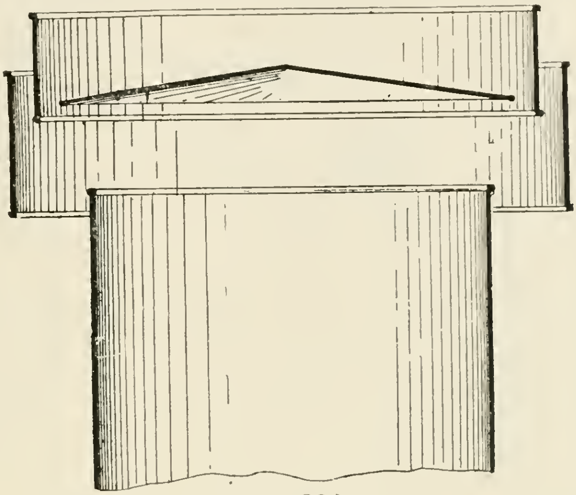


FIG. 223.

not be made of any larger size than will just bear the weight of the glass, owing to the fact that the light from above causes a shadow to be cast by these horizontal bars.

Copper.—Wherever galvanized iron or other forms of sheet metal can be used it is also possible to use copper. Cornices, downspouts and flashings and even entire roofs can be made of this material. The main objection to it in great quantities is its

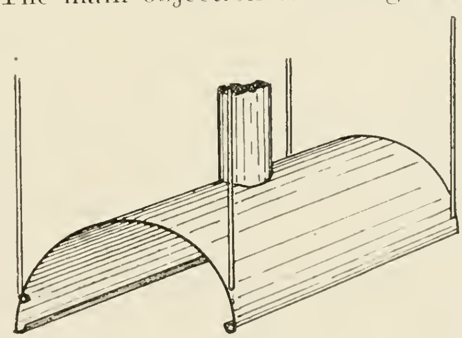


FIG. 224.

increased cost over other forms of sheet metal work, owing to the added cost of material, and because it is somewhat softer than the other metals so used.

Hoods.—All the hoods for sterilizers and for other apparatus where fumes and steam are to be conveyed from the room through the ventilators which have been mentioned herein are ordinarily

made of copper. This copper is planished or polished. Such hoods are usually made by the manufacturers of sterilizing apparatus, but as the requirements in no two cases are exactly alike, all hoods are ordinarily made to fit the particular place for which they are intended. These hoods should be thoroughly reinforced

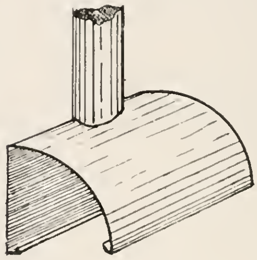


FIG. 225.

and can be hung either free from the ceiling, or they can be set to the wall and suspended. Figs. 224, 225 show the two methods of these. These hoods should all have condensation gutters which lead to a small tube or spout properly connected or drained into a sink.

CHAPTER XXI.

FLOORS AND WAINSCOTS

This subject is one which has been discussed at greater length and with more diversity of opinion than probably any one portion in the construction of hospitals. There seems to be no general agreement of opinion on the subject, nor are there any standards which can be made. Precedent bears no relation to the subject, apparently, for what is considered ideal by one authority will be disparaged by another, until there is divergence that is both confusing and unfortunate. Observation and test by actual experience does not seem to be conclusive evidence of the superiority of one material over another. Glass for wainscots was thought to have solved the much-mooted question for operating rooms, but no sooner was the decision given that this must be the best material for the purpose than some one brought conclusive proof that tile is superior. As an example of this, in the discussion of the best material for floors for operating rooms, Dr. Hurd says:

"I think I can say that on the whole there are no good floors for operating rooms, wards and kitchens. I mean by that, no perfect floors. Of course, some floors are better than others, but all of them need careful management. I think it was Webster who said, 'If I write upon copper it will corrode; if upon marble, it will perish away.' And I think the same could be said of any article for a ward floor. We think the best floor, if you can get the best material and get it carefully laid, is a maple floor. It is a floor, however, that needs great care, and it is a very uncertain floor for old gentlemen. Next in point of durability comes the rift-sawed Southern pine. If that is properly taken care of, and not rubbed to death, I think you will find it a very pleasing floor, not as slippery as the other, and in many respects is best.

"Within the past few years, however, I have come to have different ideas about ward floors. Some six years ago, when our ward floors began to give way, and the question came up as to whether we should renew the floor or in some way protect it, I decided to place linoleum of a color very much like hard pine on this ward floor. I also found that by going to the manufacturers that I could get it of any width. I therefore had it made twelve feet wide. I also had considerable difficulty in finding a substance

that would have a pleasing appearance to be used to fasten the edges down; and finally brass strips were used, covering the edges of the material and fastening it securely. This linoleum was laid down some years ago, and has been treated the same as a hardwood floor, oiled and rubbed with wax and kept good with turpentine. That linoleum is as good as the day it was laid down, and it looks as well. I think so well of it that if I ever should build a new hospital ward, I would have comparatively cheap flooring put down and cover it with linoleum. It makes a very satisfactory floor. It is cemented down. I have had some experience with rubber tiling, and I do not like it. I have had some experience with cork tiling, and it makes a very satisfactory floor. The only objection is that it costs more and will not lay as level.

"For the operating room, I do not know of anything better than hexagonal tiling. It should be laid with the greatest care. The great difficulty is that sometimes the bedding is uneven."

"Linoleum ought to be put face down in summer along the corridor and tramped over two or three weeks to get the stretch out of it. I do not know just what happens to it, but we get it more uniform. When it is first laid down I have sometimes known of the difficulties of which Mr. Test speaks; it is due to the fact that there is air under it when it is laid down. Frequently if it is raised on one side and the air let out you do not have this trouble. You do not have this trouble anyway if it is carefully laid down and the stretch taken out of it."

There seems, therefore, to be some opinion that linoleum is adaptable to wards, but from experience the authors have found that the ordinary maple floor, properly laid and taken care of, is as satisfactory as any other floor for this purpose. The subject, however, is one which apparently is rather a matter of opinion than of a scientific and careful research and observation. Climatic conditions, the class of patients, the wear and tear owing to usage, and the general conduct of the institution are all elements to be taken into consideration. The subject is treated therefore from the point of adaptability, economy and construction, and is set forth for each space for each material.

Floor classifications are:

1. Wood.
2. Linoleums.
3. Cork.
4. Terrazzo.
5. Tile.
6. Glass.
7. Marble.

The spaces in which they are placed are: Rooms, wards, corridors, administration and operating department, toilet rooms and kitchen departments.

Wainscot classifications are:

Cement.

Slate or soapstone.

Tile.

Marble.

Glass.

The spaces in which they are placed are: Corridors, operating department, kitchen department and toilet rooms.

Marble for ornamental purposes will not be dwelt upon, as there is no limit to such a classification, it being a subject wholly on the esthetic side, and not on the practical or necessary.

Wood Floors.—The laying of such floors and their treatment has been fully explained elsewhere. In hospitals they are adaptable in all spaces where strict economy is necessary, except operating rooms. While this feature of economy may be expedient, it is not practical in the end, as the constant care which is necessary in much traveled spaces, such as corridors, would more than offset the cost of some other form which would be less liable to wear and tear.

Maple floors are the best of wood floors, as the wood is close-grained, and if properly seasoned and finished it is admirable. In laying these floors they must be closely and carefully driven and securely nailed.

Linoleum.—What Dr. Hurd has said in reference to this material fully covers its qualities. It might be added that it is not the ideal floor for corridors. The inlaid linoleums are the best under all circumstances, although their first cost is considerably more than that of the ordinary print varieties. The latter are not to be compared in wearing quality, as they will not last more than a year or two at most, while the inlaid kind will last for many years. Inlaid linoleums are of two kinds—the ordinary linoleum, which is about 1/8 inch thick, and the cork linoleum, about 1/4 inch thick. The former comes in widths of two yards and in lengths up to thirty yards. With these it would be necessary to have but two joinings in wards up to eighteen feet in width, as the linoleum would be run the length of the room. Brass strips are not recommended for the covering of the joints, as they protrude, however flat they may be, and furthermore the linoleum can be laid by tacking along the edges. The security of the joints can be materially enhanced by cementing the joining edges, covering a space of about two inches in width and running the entire length of such joints.

Buckling of linoleum is due to several causes, all of when can be avoided without laying the material face down for a considerable period, as suggested. This is neither convenient nor expedient. The material must be carefully laid by experienced men, and the rooms should be neither hot nor cold when this is done. The main precaution to be noted, however, is the condition of the floor over which the linoleum is to be placed. Such floors must be absolutely dry. Mopping them before the material is put down is never to be done, and if they are scrubbed this should be done far enough in advance to permit them to dry out thoroughly.

Cork linoleum is admirable in many ways. It is noiseless, warm and sanitary. It should be laid like the ordinary inlaid linoleum, the same precautions being necessary in the laying as are observed for the latter. Cork linoleums can also be cemented over the entire area. This, however, is not necessary. There are cork tiles which are laid in this manner, and which are finished and treated like wood floors. They are not subject to much expansion and contraction and have many superior qualities. In laying these, however, it is not necessary to have a wood floor under them, as the cement into which they are set can be put over tile or rough concrete. The cement is put into all joints as a grouting, and the floor has a continuous appearance. The objection to such floors is their comparative shortness of life. They must be refinished frequently. They are made of small particles under extremely high pressure. They can be used in rooms and wards, but are not a good material for corridors.

TERRAZZO, FLAKE MOSAIC AND COMPOSITION FLOORS.

Terrazzo.—Terrazzo in its original form had extremely dry lime mortar for its principal ingredient. Into this were placed pieces of marble, the whole beaten hard, and rubbed down and polished. In laying floors of this character, it is necessary to have a heavy concrete base not less than three inches thick. The concrete for this work, as also for tile floors and glass floors, should be made of Portland cement, torpedo sand and broken stone in proportions of one of cement to two parts each of stone and sand.

Terrazzo, or, as they are more commonly known, flake mosaic, floors in the present form are made of cement instead of lime mortar, colored if desired (this to be done with mineral colors only, as they are unfading), into which is put broken marble, either pure white or in colors. The cement should be best Portland, thoroughly mixed with one part of sand, and the broken marble put into this, in pieces not less than 1/4 inch thick and no

larger than ¾ inch, in sufficient quantity, so that the particles lie close together in the floor. The cement should first be waterproofed (as described elsewhere) by mixing into the cement materials specially prepared for this purpose. These prevent water, acid or oil stains on the floor, and make them so that they are easily cleaned. They do not affect the setting or hardening quality of the concrete and prevent efflorescence. After this concrete is put into place and thoroughly tamped down, it must be brought to the proper level and left to set about twelve hours and then rubbed with standstone to a true and level surface. It is then allowed to thoroughly set again, rubbed and finally polished.

These floors need not be laid continuously, especially in corridors.

It is recommended that expansion joints be put in the work, especially in steel constructed buildings, so that if there is any settling of the building no cracks will occur, but that the cleavage will go along the lines of these joints, which can then be grouted or filled with cement. These joints can be made of tile or of marble in tile shape, about three-fourths inch square.

If the cement has not been waterproofed, the floors should be treated with a coating of cement filler and then cement floor paint. Floors so treated are impervious to water or oil. This prevents disintegration of the cement surface and dust produced by friction of shoe soles. This process is not as economical as the waterproofing process, as it is necessary to repaint the floors frequently.

These floors are used in corridors, entrance halls, operating and dressing rooms, recovery rooms, toilet rooms, laboratory and public offices, waiting rooms, kitchens and kitchen store rooms.

Tile.—Tile floors are made of vitreous tile, which come in square, round, hexagonal and octagonal forms. These can be put into floors in combination and in colors. They run in size from three-fourths inch to the large red and white tiles six and eight inches in size. The two and three inch hexagonal tile make the most satisfactory floors. The base for these is the same as for the flake mosaic variety. The tile are laid in cement, grouted to true and level lines, and after they are set the joints are grouted. The grouting for laying tile is made of two parts of Portland cement and three parts of clean, sharp sand. The grouting for joints is made with clear Portland cement and must be cleaned off the face of tile before it sets. If there is any settlement in the building the line of separation between tiles can be easily regrouted. The tile are impervious to water and oil. Tile floors when installed are used in the same spaces designated for flake mosaic floors.

GLASS.—Glass for floors has many advantages over other forms, as well as some disadvantages. It is impervious to water, oil and acids. It comes in large pieces and thus allows a minimum of joints in such floors. Its great disadvantage lies in the fact that it chips very easily, and heavy objects dropped on it at a corner or on an edge break it or chip it at such a point. In such instances there is no manner by which the damage can be remedied except to replace the entire slab. The floor in "hone" finish, that is, ground or sand blasted to a mat finish, does away with the possibility of a slippery surface—that is, it is no more so than a tile or mosaic floor. This form is extremely expensive compared with flake mosaic, and while it has many advantages over the latter, it has decidedly greater disadvantages. It is laid in cement in the same manner as tile is laid. Thus far it has only been used in operating rooms and toilet rooms.

MARBLE.—Marble for floors in hospitals is not to be recommended. It is soft and wears unevenly. It is absorbent to a great extent, and when once discolored cannot be thoroughly cleaned. It has the disadvantage moreover of slowly discoloring—turning yellow with age. Owing to its coarse and granular texture it breaks readily and must be replaced, as it cannot be patched.

SLATE AND STONE.—Slate and stone of slate variety type can be used for floors, but owing to the color they are not desirable. They can be used, however, in toilet rooms, where they are preferable to marble or glass, as they are practically impervious, and have the added advantage of being economical both in first cost and in subsequent repairs.

COMPOSITION FLOORS.—There are many floors of this character which are meant to take the place of marble, tile or flake mosaic. They have been used to some extent, but the majority of them are of too recent introduction to warrant their recommendation. There are several of these made on a cement basis with other materials, and may be obtained in a multitude of colors. In one form instead of using marble for the flake effect, broken shells are used, and the appearance of the floor is very satisfactory. It is claimed, and reasonably so, that the floor with shells is superior to a floor with marble flake, inasmuch as the former is impervious and sanitary, while the marble is absorbent.

There are also floors which are made on a composition base that contain small particles of wood, intimately mixed into the mass. It is claimed for these that they are quieter and warmer than the ordinary cement, tile or composition floor, but it is doubtful whether this claim would justify the use of a floor in which

a material as easily destructible as coarse sawdust enters, and which would, in a short time, have the wearing surface pitted, thus making a place for the lodgment of organic and inorganic particles.

There is also on the market another composition floor which

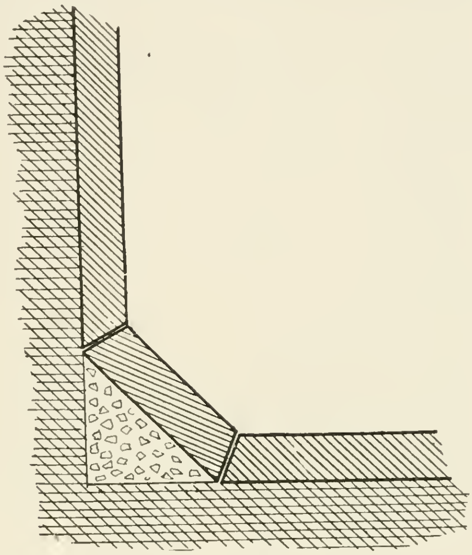


FIG. 226.

is treated with oil and polished much in the same way as wood floor. It is claimed that it is absolutely sanitary and has excellent wearing qualities.

Floors in toilet and bathrooms should be thoroughly waterproofed in the same manner as described for basement floors.

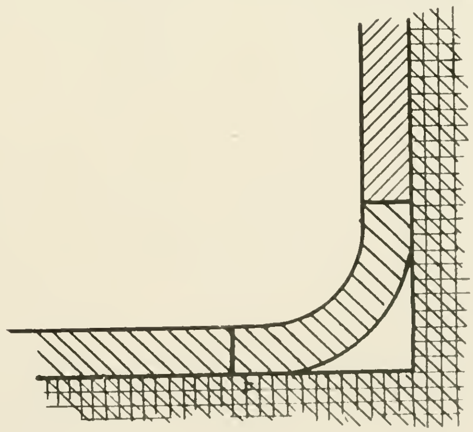


FIG. 227.

Coves.—The connection between floors and walls and wainscots in all hospitals should be in cove form throughout. This is not primarily so much to guard against micro-organisms as it is to favor absolute cleanliness. Sharp angles and corners along the

floor line cannot but be a collecting place for dust and dirt, which the utmost care and cleaning will not wholly dislodge. A cove can be mopped as readily as the remainder of the floor. Elsewhere in

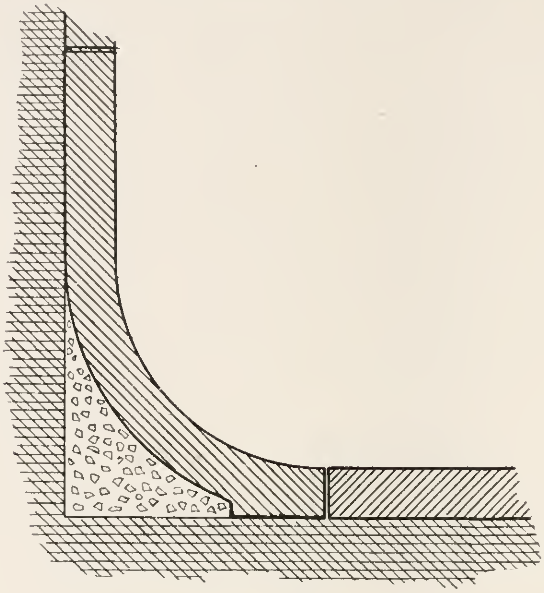


FIG 228.

this volume the subject of coves has been mentioned, together with the manner of putting these into the building. The materials for making these coves are numerous. In rooms and wards they can

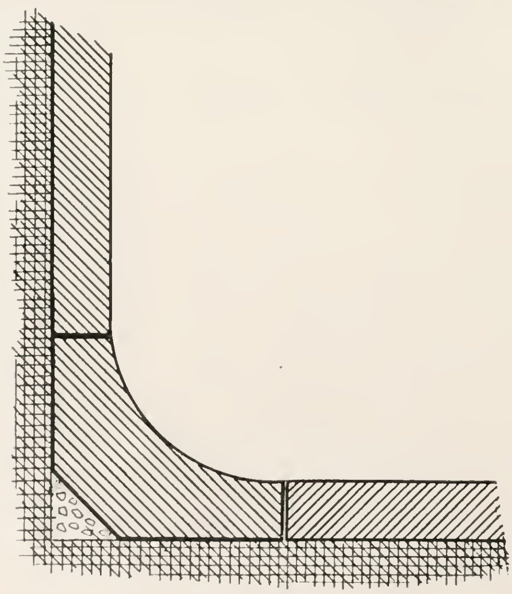


FIG. 229.

be made of wood, as shown in Figs. 33 to 36, or they can be formed by the plaster, as shown in Fig. 161. This applies particularly to coves in connection with wood floors, either covered or uncovered

Coves of cement, marble, tile, glass, slate and composition can be used in place of such wooden coves, but the cement or composition coves are fully as good as the more expensive ones. Coves in connection with floors made of mosaic, tile, marble or glass can be of any of these materials; glass floors also should be equipped with glass coves if the wainscots were also of glass. This, it might be stated, is not, strictly speaking, a cove, but is put in as shown in Fig. 226, and has very wide angles. The floors can be equipped with tile coves which are made in patterns from the small two-inch radius cove to the cove and base combined, as shown in Figs. 227-228. Flake mosaic floors are ordinarily equipped with coves made of the same material, cast in lengths of about four to six feet, or run in molds continuously in place. This also applies to the compo-

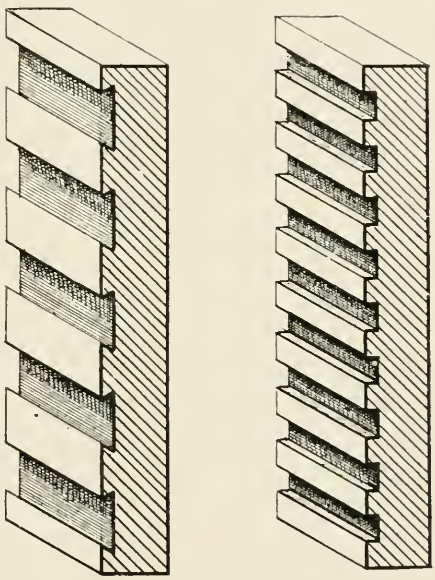


FIG. 230.

sition and all cement coves. It is more satisfactory to have the molds made and set than to run them, as they can then be machine rubbed and the surfaces made more even and true. Slate floors would have coves of the same material, of soapstone or cement. These soapstone and slate coves are machine made, are admirable in all ways, and are recommended for rooms, wards, toilet rooms and even corridors, in connection with any kind of floor where darker colored floors are used. They are absolutely sanitary and impervious. Marble coves are not impervious and except where marble wainscots are used in connection with floors of the same material are not recommended, as they are liable to be broken and besides are quite expensive.

Base Blocks.—Wherever floor coves are used the base blocks

should be of the same material as the coves, and should be so designed that they form no sharp corner with the cove for the lodgment of dirt.

Wainscots and Walls.—These can be made of cement, slate, soapstone, tile, marble or glass, dependent usually upon the space in which they are to be placed. Operating rooms are ordinarily equipped in tile, glass or marble, the height usually depending upon the amount which can be expended for this portion of the work. Marble is not wholly satisfactory, owing to the fact that it is easily scratched and marred, and also because it turns yellow under repeated cleaning, such as is administered in operating rooms. Tile is impervious, does not mar or scratch, but is subject to crazing. It has also the disadvantage of having numerous joints, but if these are properly filled with waterproofed cement

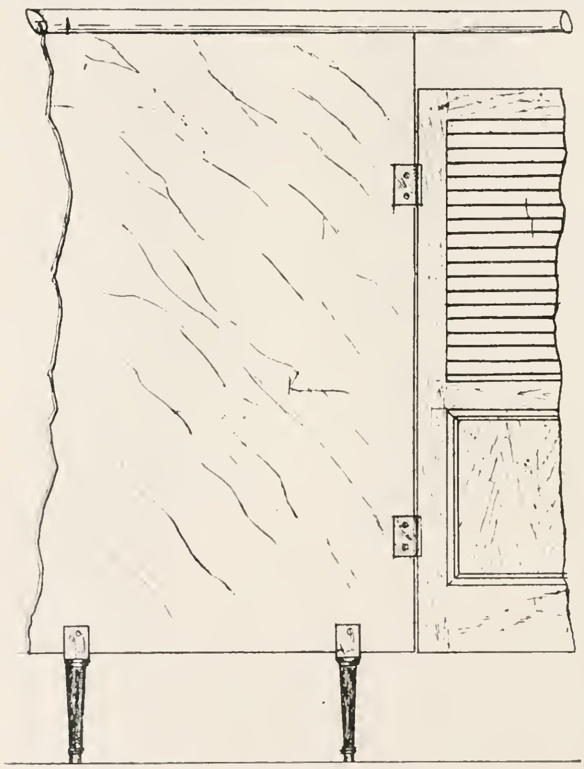
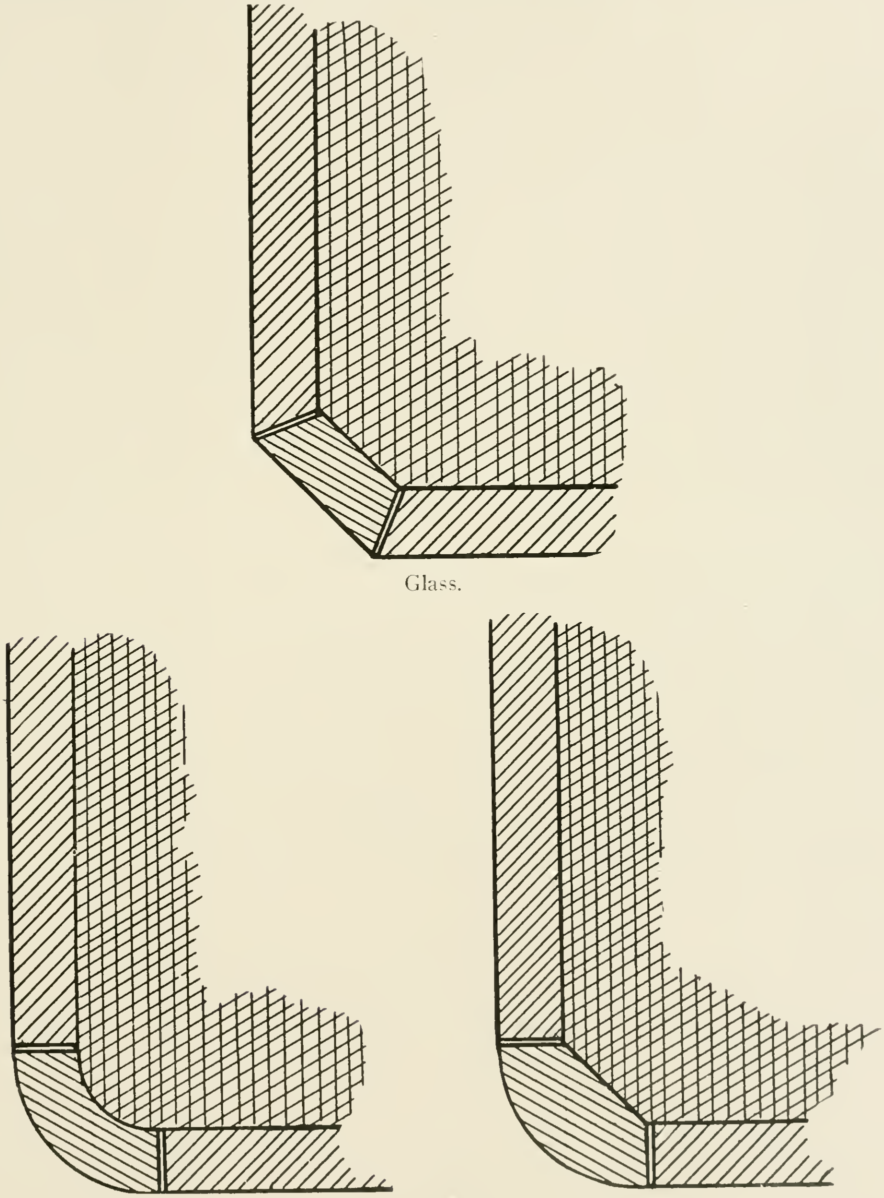


FIG. 231.

grouting, this is not a serious objection. Tile should be put on wet over a Portland cement base and should always be of the lock back pattern, as shown in Fig. 230. Glass for wainscots is practically a new product. This glass is milk white and is absolutely impervious and acid proof, as it is made like ordinary plate glass and polished in the same manner. The chief objection to this material is its liability to chip in setting, its liability to show stains,

and its present high cost of installation. "Hone" finishes should never be used on wainscots of this material, as they soil too easily.

For corridors, cement, tile, glass and marble are most often used, but the cement and tile, except for corridors in the operating department, are fully as good as those made of other materials,



Glass.

FIG. 232.

Marble. Tile.

and have the advantage of being less expensive. The cement wainscot could be painted or enameled, and in all corridors, except as mentioned and on the first floor, this would in no way detract from the value of this material for a wainscot. The wains-

cot on the first floor of a hospital is usually of other materials than cement for esthetic reasons, and not because they are more adaptable. In kitchens and nurses' rooms cement wainscots are admirable, although tile can be used. Marble should never be used in these rooms, as it absorbs any liquid, acid or grease which is put upon it. In toilet rooms, wainscots and partitions can be made of marble, slate, soapstone, rough wire glass and the white glass. All partitions should be put up in such a manner that the entire floor is as nearly clear of obstruction as possible. Fig. 231 shows a partition. The standards for raising these partitions, except those of wire glass, are of nickeled brass or white metal. A cap mold can be run over these partitions in order to give them the necessary rigidity and support, but the nickeled brass or white metal tube, as shown, is preferable, as it is stronger and stiffer than the partition material. Wire glass partitions are made of angle iron frames, the glass being set in these frames. This partition has the great advantage over those made of all other materials in that it permits the maximum amount of light to penetrate into all spaces in the toilet room divided by these partitions. There is, however, a serious objection to the use of this material for partitions in bathrooms, because the outlines of the bather's body can be recognized through these partitions if the bathroom is lighted artificially at night. The wainscot in these toilet rooms can be of slate, soapstone, marble or tile, or the entire walls can be of cement and thoroughly enameled. All wainscots should have rounded corners, as shown in Fig. 232. In operating rooms rooms the door and window jambs and trim can also be made of the same material as the wainscot of the room. Sills, as mentioned elsewhere, should be of materials other than wood.

CHAPTER XXII.

ILLUMINATION.

In treating this subject the different methods in use will be given and as far as possible the hygienic effects of each will be set forth. These latter are principally quoted from papers on the subject by physicians who have made investigations.

The difference between light and illumination should be carefully noted. Light is a cause; illumination an effect. An object on which light falls becomes illuminated. Illumination, therefore, is the result produced by light. An object is well illuminated when it can be easily seen without fatigue or strain on the eyes. Good illumination, therefore, requires several things, among which may be mentioned:

1. Sufficient light to enable one to see clearly and distinctly.

2. Avoidance of too much light, which produces a blinding and fatiguing effect on the eye.

3. Avoidance of having a bright light in the field of vision, which cuts down the ability to see clearly things which are less brilliantly illuminated.

4. Avoidance of streaks or striations, which, however, are more noticeable with electric than with gas lights.

5. A steady light—i. e., avoidance of a flickering light, like an open flame burner with insufficient draft, which quickly tires even the strongest of eyes.

6. Avoidance of regular reflection, which is commonly known as glare, due to the light striking an object at such an angle that a large part of the light is reflected directly into the eyes.

7. Avoidance of too sharp contrasts, such as, for instance, a brilliantly lighted desk with the rest of the room in darkness.

From the foregoing it will be seen that, in considering any form of illumination, it is absolutely necessary to take into consideration the effect on the eye. Nature has given us in the eye a wonderful and delicate camera, which, with proper care, can be used indefinitely, but which, with the introduction of lights of high intrinsic brilliancy, we have shamefully misused.

In dealing with modern sources of light it is, therefore, necessary to take into account the effect of the same on the eye, and

in every case reduce the intrinsic brilliancy as far as possible. With electric incandescent lamps it is possible sometimes to conceal them entirely from view, thus getting indirect illumination, which is generally satisfactory, except from the standpoint of economy. With gas such treatment is usually out of the question, although not always so, and we should, therefore, place our lights high enough to be out of the field of vision wherever possible, and to use diffusing globes, which not only cut down the intrinsic brilliancy, and, therefore, make it possible to see with much more comfort, but actually enable us to see more clearly, owing to the eye being enabled to work with a wider aperture. It is, therefore, necessary to study the effects not of the light alone, but with the glassware which it is desired to use. The absorption or loss of light due to the surrounding globes, as well as their distribution, must be considered.

In addition to the above requirements the following also must be taken into consideration:

First—The plan of the floor and height of ceilings as laid out by the architect.

Second—The purpose for which the various rooms are to be used.

Third—The luminant, or means of producing the light.

Starting from these fixed conditions we must determine:

First—The requisite intensity of illumination on some assumed or real surface in each room.

Second—The location of the light sources.

Third—The candle power and distribution of the light units.

The first condition to be settled is the question of intensity of illumination. It is on this particular point that the lay mind is usually most seriously confused, owing largely to the loose and ambiguous manner in which the various terms of expressing light measurements are used. The term "candle-power" suggests at least a definite idea, on account of the familiar 16-candle-power electric lamp; but the term "foot candle" is absolutely meaningless to the layman and expresses but a vague idea to the average architect or engineer; yet it is precisely this measurement that is the foundation and starting point in practical illuminating engineering.

The apparent brightness of intensity of illumination of the surface as seen by the eye depends not only upon the amount of light falling upon the surface, but upon the amount of light which the surface reflects to the eye. Scientifically expressed, it depends upon the brilliancy of the image on the retina. This visual intensity, which is the final result that we are after, is, therefore, the

intensity of illumination received, multiplied by the co-efficient of reflection of the surface illuminated. This simple fact is often lost sight of in estimating the intensity of illumination required.

The prime factors in determining this question of intensity are, therefore, the purpose for which the room is to be used, and the color of the surfaces which are the special objects of the illumination; having these given, the determination then is a matter of judgment based upon actual experience.

According to Fechner's law, the human eye can perceive a fixed fractional difference of illumination, irrespective within wide limits of its absolute amount. This fraction varies in general from about 1 per cent. to about .55 per cent., assuming ordinary sources of illumination and normal eyes.

Now for the purpose of practical lighting the illumination should be generally kept within the range for which Fechner's law holds good, and once well within that range of normal sensibility nothing is gained virtually by increasing the strength of the illumination, so far as difference of luminosity is concerned.

It therefore plainly appears that at 1 or 2 foot candles the eye is working so near its normal sensibility that further increase in illumination is of relatively very small value.

The essential point on good seeing, however, is that the values here specified should be those affecting the eye and not merely those by which objects are illuminated.

Since objects are seen in virtue of differences of reflected light the illumination which affects the eye is determined by the co-efficients of diffuse reflection of the objects in the field of view.

As stated above, any violent contrast in the field of vision is objectionable, so that if conditions are such as to require powerful illumination in a part of the field a very bright background in the rest of the field should be avoided, it being preferable to have there merely enough light to avoid excessive contrasts.

As most objects are colored, the relative luminosities of various colors are important considerations in illumination, and that the eye is affected by various colors in very different degrees is well known. The luminous part of the spectrum lies mainly between wave-lengths 700 mm. and 400 mm., the effective part of it lies between w. l. 630 and 530. Energy outside these limits is for the most part wasted so far as vision is concerned.

At first sight, therefore, the eye would seem to be very inefficiently organized. Such, however, is not the case, for the eye has been evolved not for artificial light, but to meet the exigencies of natural light, and its point of maximum luminosity falls very near

to the point of maximum energy of the solar light; in fact, between that and the maximum energy point for skylight, so that the adjustment of the sensibility for natural conditions is excellent.

Moreover, were it not for the adjustment of the eye for a sharp maximum of sensibility, we should be totally unable to see clearly on account of the effect of chromatic aberration. When the eye is accommodated for yellow light images due to deep red and deep blue light are badly out of focus, and were they comparable in brightness to the yellow image near vision would be very indistinct, and aside from this we should lose much of the contrast which helps to render objects visible. As was long ago noted by Purkinje and Dove, the relative luminosity of different colors is greatly affected by the absolute intensity of the illumination.

The flaming arc is one of the most efficient illuminants yet found. But the light has a large color error which can be corrected only by a considerable sacrifice of efficiency.

Could one steal the firefly's secret the result would be, if Langley's experiments correctly represent it, a light of high efficiency, it is true, but of about the color of a superannuated Welsbach.

ILLUMINATING WITH GAS.

Gas as an illuminant is rapidly decreasing owing to the introduction of electric lighting and the reduction in price of the latter. But however much this reduction may be, the open flame burner will be used for years to come and gas for illumination will probably never be wholly replaced universally. The electric light is more adaptable, requires less care and produces less heat; to offset these advantages, gas light is much more economical.

Having an economical advantage so largely in its favor and apparently unattainable by any system of electric lighting, gas lighting has rested upon this single point of superiority, and as a result it has assumed a secondary place in illumination; that is, it is used where electric lighting cannot be afforded or obtained. Recent discoveries in the production of electric light are of so revolutionary a nature as to very seriously threaten this chief vantage ground of gas lighting. The same principles which have been utilized in the cheapening of gas light—that is, the use of the peculiar properties of the so-called rare earths and metals—are at last being appropriated by the electrical interests, with the certainty that in the near future the efficiency of electric lighting will be at least doubled.

The simplest form of gas lighting and the one with which all

are most familiar is the old gas tip—either of the lava or steel form. This needs no special mention, but a few words as to the size and use of these may be of assistance if such are used.

Burners should be in line with the center of the fixture. This gives all of the light and does not to any extent injure the effect.

A source of insufficient lighting is often found in the imitation candles with small tips which are put on fixtures.

It might seem that in changing the tip from a smaller to a more efficient burner that the bills for consumption of gas would be increased, but this is not true, for if a standard open flame burner is used and this be taken off and a small tip burner be substituted, it will be found in comparison for the amount of illumination given that the standard flame burner will consume about half the amount of gas which would be necessary to give the same illumination with the smaller tip. All tips, however, must be kept clean and only those used which are approved and have been proven to be efficient.

Incandescent Mantles.—The form of gas lighting most commonly used at present is with the incandescent mantle. These are to be obtained in almost any size, shape and quality. In fact, it has been confusing so rapid has been their increase. They are all, however, of the same general pattern so far as their lighting quality is concerned.

The earlier forms of these was the Welsbach burner, with tall, straight chimneys, and small fluted porcelain reflectors and were hopelessly ugly. Add to this the greenish cast of the light which the mantles, particularly when old, gave forth, and their excessive glare, and the combination made a very poor second to the comparative elegance of the incandescent lamp with its usually small or less ornamental shade. Later an attempt was made to imitate the most effective form of electric lamp, so far as appearance is concerned, that is the arc lamp.

Globes.—A source of ineffectiveness in lighting, as well as an additional cost for lighting, has been found in the pattern and color of the light or of the globes which are used, the latter probably for some decorative effect. Undoubtedly people will continue to use schemes of interior decoration when utility should be their first consideration. As stated herein, the best type of globe for illumination in hospitals is some kind of scientific prismatic globe, which has been given proper amount of study. In all instances the manufacturers of such globes should be consulted if the lighting is not attended to by the architect, who would, of course, specify the proper globe to be used for the specific form of lighting intended in any given space.

If gas is to be installed and used, the following will be of special value:

The average consumer seems to have no idea of the loss in effective illumination through the use of unsuitable globes. It is, of course, well to utilize globes to soften light, but not to obscure and reduce illumination. It is strange that with all the very apparent advantages of the Holophane globes and shades, they are but little used on this side of the Atlantic.

A source of criticism has been found in the use of globes where the bottom openings were of small diameter; the drafts up through the globes due to these, set the open flame burners flickering badly, causing eye weariness, and in many cases the substitution of even oil lamps to overcome this. Under no circumstances whatever should the old type of globe be used. We often see the user of illuminants start out with clean appliances, and as they become clouded with dirt they have to double the unit of light in use and then condemn the purveyor. If ordinary clean glass obstructs 10 per cent. of light, and opal globes 60 to 70 per cent., imagine the loss of light and the cost of lighting when chimneys or bulbs build upon their surfaces successive laminations of opalescence. It does seem strange that it is necessary, in this age, to prove that it pays to keep clean. This loss of light due to fouling of globes is very much more serious where ground glass globes or opal globes are used, than with clear glass; as the fouling is so gradual and so near the color of the globes themselves that it takes months before they become noticeably dirty. In the meantime additional units of light are brought into use and expense increased to the consumer.

Without disparaging the inverted burner, it may be safely asserted that the upright incandescent gas lamp can be made quite as decorative and elegant in appearance as the incandescent electric lamp. It is worth remarking also that while the gas lamp manufacturer has been struggling to turn his lamp downward after the fashion of some electric lamps, the electrical fixture makers and decorators have been turning their electric lamps upward in an endeavor to imitate candles and gas flames.

HOLOPHANE GLOBES.

The Holophane System is used largely in hospital lighting, owing to the fact that the globes give practically as good diffusion as opal, with a very small loss by absorption, being only about 12 per cent. on the average, and at the same time having the property of directing the light in directions wanted. In general they are made in three types:

Class A, to throw the maximum light directly down.

Class B, for spreading the light uniformly below the horizontal.

Class C, to throw the light sideways.

FIG. 233.

Fig. 233 shows a Class A globe designed for a mantle burner.

Fig. 234 shows a Class B globe.

Fig. 235 shows a Class C globe, all intended for standard burners.

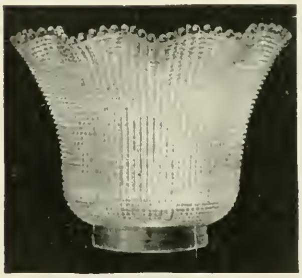


FIG 234.

Fig. 236 shows a Class A stalactite for electric light, intended for use where it is desired to throw the strongest light directly downward.

FIG. 235.

Fig. 237 shows a pendant ball designed for general distribution of light.

Fig. 238 shows a pendant open globe for general distribution.

Fig. 239 shows a globe for bracket lighting which is designed

with reflecting prisms on the back so that but little light reaches the wall, the majority being thrown out into the room.

Fig. 240 shows an upright globe for general distribution of light.

FIG. 236.

Fig. 241 shows a globe for the ordinary flat-flamed burner, intended for general distribution of light.

Fig. 242 shows another form of globe.

FIG. 237.

HOLOPHANE REFLECTORS.—These reflectors, which have become such an important adjunct in lighting, are made at present only for electric lights.

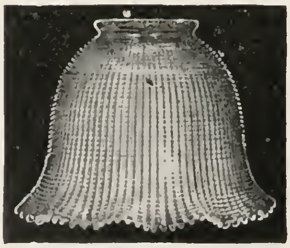


FIG. 238.

Fig. 243 shows a form of reflector for throwing the light strongly downward, giving no less than 56 C. P. directly underneath the reflector when equipped with a 16 C. P. lamp.

Fig. 244 shows a reflector for throwing a strong light sideways

and is designed to give uniform illumination over a large area at the same time being deep enough to hide the lamp from view.

Fig. 245 shows a reflector for throwing a strongly distributed light.

FIG. 239.

Fig. 246 shows a Holophane Cluster equipped with 40 C. P. Gem high efficiency lamps consuming the same amount of energy as an arc lamp, but giving considerably more illumination and at the same time giving the soft light which is so desirable in hospitals.

FIG. 240.

Figs. 247, 248, 249 are types of globes, Fig. 247 giving a wide distribution, and Fig. 248 giving a strong downward light. Fig. 249 is a "bowl" reflector, which brings the light down and spreads it at the same time.

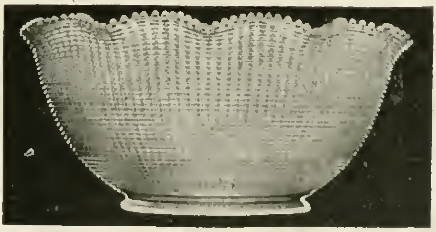


FIG. 241.

Acetylene.—Acetylene is not recommended for hospital lighting, although it has merits which would ordinarily make it an ideal illuminant.

Horace Allen says as to its demerits:

"Though the demand for acetylene gas has steadily and continually increased ever since calcic carbide became a commercial commodity several years ago through the development of the electric furnace, it is doubtful whether it will ever seriously enter

FIG. 242.

into competition with either coal gas or electricity in the field of general and economical illumination for public or domestic purposes or for power development. The chief item of expense being for current, the possibilities in the way of price ever coming within

FIG. 243.

the range of competition are very remote as long as electricity is employed in the manufacture. Added to the cost of manufacture, there is necessitated the expense of packing in hermetically sealed

FIG. 244.

drums and tin canisters, owing to the great affinity of calcic carbide for moisture.

Pure acetylene gas is credited with having a faint, sweet smell, but the smell given off by all the carbide the writer has had the

opportunity to examine has been quite the reverse of either faint or sweet.

The unpleasant odor arising from raw carbide upon opening the receptacle is a primary source of objection, and any neglect

FIG. 245.

in the way of resealing the drum after the withdrawal of the required quantity, results in the continued gradual generation of acetylene and its objectionable smell. For this reason the best

FIG. 246.

place to store carbide is at some considerable distance from any occupied building.

To turn our attention now to acetylene, there is no doubt

that the light is of high quality, both in regard to illuminating power and its preserving the natural colors of materials, etc.

A drawback which has given considerable trouble is the necessity for a very fine orifice in the burner, but even now while the jet is of such small dimensions, it is liable to be stopped by the slightest particle of dust, or, on the other hand, carbon becomes deposited and a heavy smoke flame results.

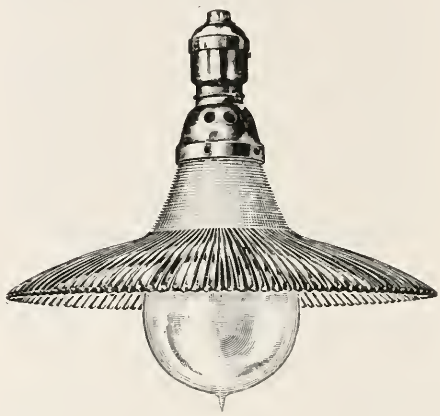


FIG. 247.

To prevent the deposit of carbon at the orifice of issue from burners, a very common source of trouble, the device of providing duplicate orifices at such an angle that the two issuing jets are made to impinge upon each other and form a clear flat flame, was claimed to be successful.

FIG. 248.

This class of burner found much favor as an improvement over the single jet, but it not unfrequently happens that some slight particle of dust lodges in one of the jets and deflects the flow of gas to such an extent as to prevent the two jets meeting centrally; the result is a very unsatisfactory flame, which can only be rectified by inserting a fine needle or wire into the clogged

orifice. This would seem to be a very simple matter, but it must be borne in mind that the burner goes wrong just when the light is required, and it is necessary for the acetylene gas tap to be closed and some other light obtained to enable the clearing of the burner to be effected, owing to the minuteness of the hole in the burner and its angular direction; to insert the wire in the orifice in most burners is quite on a par with threading a needle with the eye in a rather inaccessible position.

Some burners have the orifices in such a position as to render it a very delicate matter to clear them on their becoming clogged, but the simplest way to overcome the trouble is to provide spare burners, it being an easier matter to change the burner than to probe it.

While ordinary coal gas in course of time reduces leakage, through deposit, this is not the case with acetylene, so that all joints must be thoroughly sound from the first.

In regard to leakage, the unpleasant distinctive odor of im-

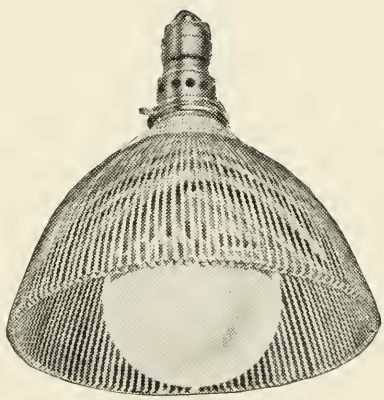


FIG. 249.

pure acetylene has the advantage of quickly indicating the existence of a leak and its locality. When the gas is purified properly there is less evidence, and, therefore, greater danger from this source of trouble.

Owing to its high specific gravity—.9, or twice that of coal gas—it does not so readily diffuse and pass away, and although the smallness of the jets renders the volume passing out in a given time considerably less than in the case of a coal gas burner, though it must be borne in mind that the pressure is usually about twice that required for coal gas, the escaping gas hangs round and tends to form an explosive mixture which would do considerable damage if even a smoldering bit or glowing cigarette should be brought near, the ignition point being only 896 F., while so small a proportion of acetylene as 3.5 per cent. forms an explosive compound with air, as compared with 6 per cent. with coal gas."

ELECTRIC LIGHTING.

The use of electric light is so universal and nearly every one is so conversant with the ordinary electric light that it would seem useless to describe systems and methods of lighting in this manner. Ordinarily this is true, but there are so many new methods, and hospital lighting is so vital, that there is need of more detailed information on the subject.

The placing of a chandelier in the center of a room, with one or more lights and an ordinary globe, and sometimes colored globes, without reference to the primary principles outlined, is not considered scientific illumination. As has been stated, all conditions must be taken into consideration. The matter of the position of lights; the number of lights; their position as regards the patient must all be carefully figured. When these have been determined, the kind of light must be taken as a factor. The ordinary incandescent lamp is no longer considered the best form of illuminant, so far as lighting by incandescent filaments is concerned.

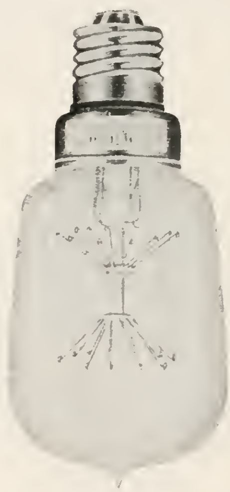


FIG. 250.
Tantalum Lamp.

The new G. E. M. lamps, which have a carbonized filament, and the new Tantalum light are but two of the latest forms of improved incandescent lamps.

The new G. E. M. filament lamp has been standardized at 50 watts, thus giving improvement in the form of an increase in candle power of 25 per cent, or from 16 to 20 C. P., instead of a reduced wattage to 40 watts per lamp. Its useful life is 750 hours.

The Tantalum lamp shown is the latest addition to the science of lighting. The Tantalum lamp has a filament composed of a

rare metal capable of withstanding very high temperatures out of contact with air and giving a very brilliant white light. The construction and general appearance and dimensions of the lamp are clearly shown in the accompanying illustration (Fig. 250). The lamp is at present supplied in but one size, having a consumption of 44 watts and giving a mean horizontal rating of 22 candle power. It is made for voltages of 100 to 130 and fitted with standard Edison base. The lamp should not be used upon alternating current circuits.

As to the best method of lighting by these lamps experts differ somewhat, but in the main the following are regarded as desirable:

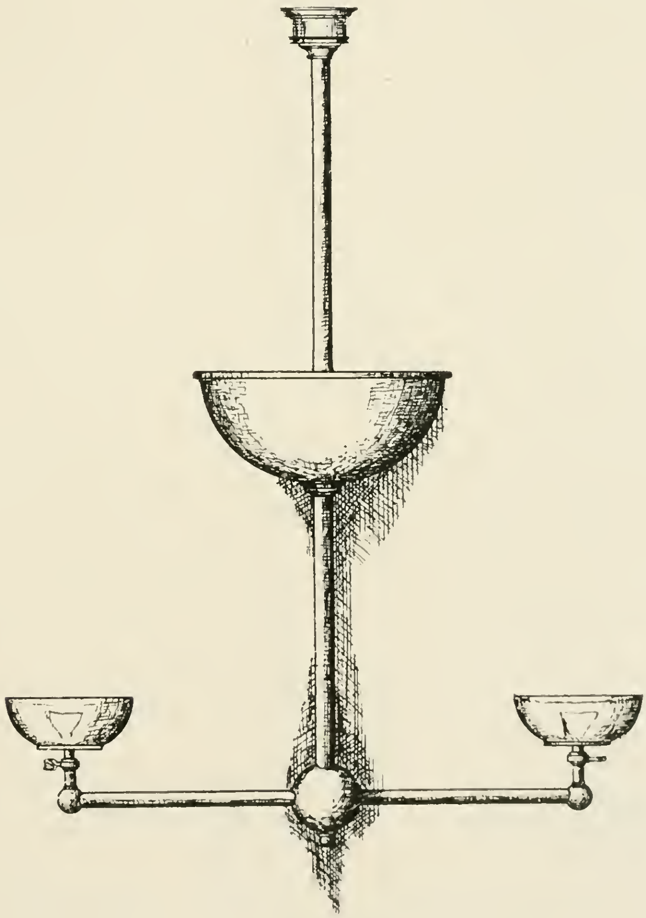


FIG. 251.

For wards, lighting as shown in Fig. 251 is admirable. The real lighting is done by electric lamps inside of the inverted spun glass bowls, which are painted white and covered with a thin sheet of glass to keep out the dust. The light is reflected from the ceil-

ing and from there to the room. This is a very good example of what is commonly known as indirect illumination, which is highly satisfactory in such places. When such a form of lighting is used there is placed at each bed, or between beds, a receptacle into which a plug can be inserted, so that an individual light can be

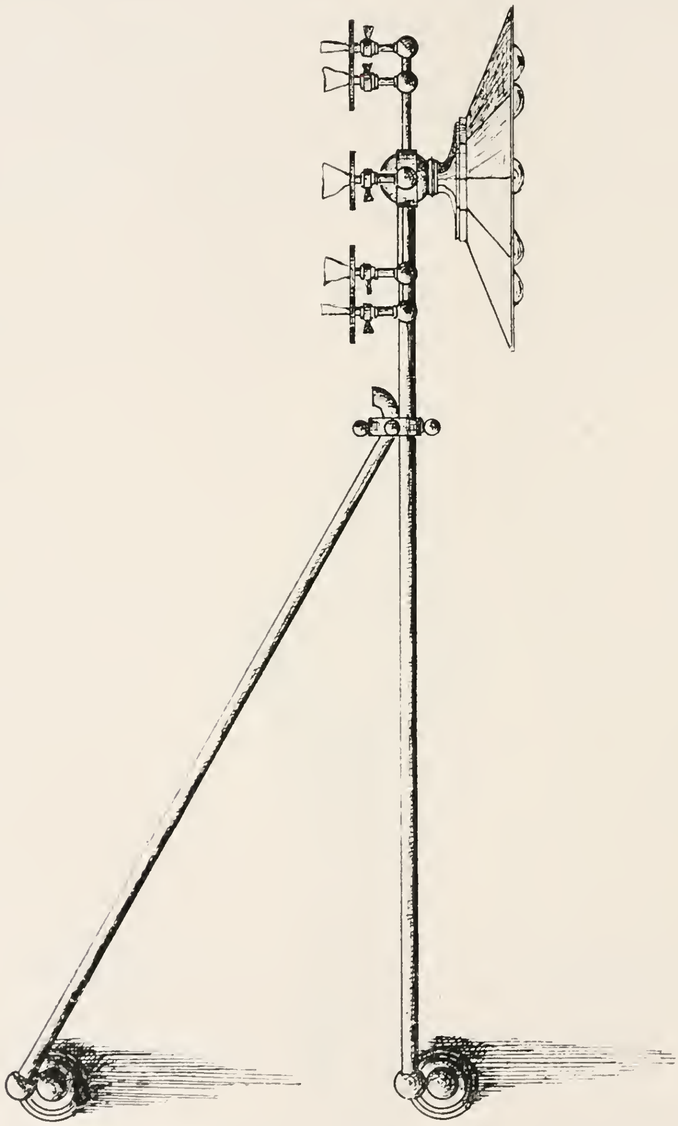


FIG. 252. Swinging Bracket.

used for careful examination of patients. Such a light should be mounted on a stand and have a flexible stem so that it can be placed in any position. It should also be equipped with a reflector and a frosted lamp.

The lighting of wards can also be done admirably with wall brackets. This enables the patient to read in bed if permitted, and also removes the glare and intensity from the other patients.

Such lights should be of about four candle power and have proper reflector to protect the eyes of other patients. A wall receptacle could be used instead of a bracket and the light fastened by a clamp to the bed. These lamps, moreover, could be equipped with pull chain sockets and be turned on and off very easily, or they could be equipped with lamps of the multiple pattern, which can be turned on fully, with a faint glow, or turned out by either a pull cord or a switch arranged for this purpose. Such lamps and switches are now obtainable and are highly satisfactory.

Lighting of operation rooms can be done in several ways with incandescent lamps. Fig. 252 shows a swing bracket with from 8 to 16 C. P. lamps and an auxiliary of gas. The objections to this form of lighting are the deep shadows owing to the change of position of the operator and the intense heat from the lamps owing to the reflector over them.

Mr. Ernest says in regard to this: "The illumination should be high, in foot candles, and shadows eliminated as much as possible. It is also desirable to have a light that will give the true color to normal tissue so that the surgeon is able to distinguish in his operations the diseased from the healthy tissues. There are, as a rule, two styles of operating rooms—the private and the amphitheater. In the latter it is necessary to arrange the lights so as not to interfere with the student body and the operator and still give the required illumination. The surgeon rarely operates in one particular position with relation to the patient or the operating table and, therefore, the light will always have to be placed so that he will not work in his own shadow or those of his assistants."

As is stated below, the possibility of shadows can be entirely eliminated by other methods of lighting.

The lighting of the remainder of the building must be studied as carefully as is that for wards, rooms and operating rooms. Corridors can be effectively lighted by chandeliers placed at proper intervals so that there are no dark spaces between. It will be necessary, however, to place the lights and choose the globes with reference to this. There are other forms of lighting corridors, as stated herein.

VAPOR LIGHTING.

The development of lighting in general has led to scientific research along entirely new lines. It has been stated by one of the experts making investigations that he was dumbfounded when he discovered that "three-tenths of one per cent. of the energy consumed is converted into light."

It is well recognized, as a scientific principle, that the most

efficient means for the transformation of electrical into light energy is electric conduction through rarefied gases or vapors. The practical application of this principle in one or another form has occupied engineers for some years past, and a most promising beginning in actual systems of this character has recently been made.

It was along this line of incandescence that improvements had to be made and the old principle of the Crook's tube was applied. The only questions were the proper gas to use, and the method of container, and the remainder would naturally follow.

The first successful attempt to put lighting by incandescent gases on a commercial basis was the Cooper-Hewitt light—a system of mercury vapor lighting with which every one is now familiar. That this form of lighting is applicable for many purposes cannot be doubted, but for the operating room or general use in hospital lighting it is out of the question in its present form, owing to its disturbance of reds in coloring schemes. Wounds would take on a color distortion to which red is subject under this light, and while it possesses a mild and large glowing surface of great magnitude and has besides the wonderful low intrinsic value of incandescent gases, the color objection cannot be waived in hospital use, although the light itself is practically available in almost every other case, with few exceptions. As in other forms of vacuum tube systems, the great steadiness of the Cooper-Hewitt light is noticeable.

The Bastian mercury vapor lamp is of English origin and is of highly practical design for this style of vacuum light. It is in more condensed form than the Cooper-Hewitt, which for ordinary use is an advantage, for the special purpose of operating light would not be of much advantage. The combination of incandescent lamp with the Bastian is possible, somewhat eliminating the color difficulty. At present experiments are being conducted on these lamps with a view to coloring the arc stream by the addition of other metals to the mercury.

Probably the best method so far developed in vapor lighting is the so-called Moore tube. This has been placed upon a commercial basis and the many installations of this light attest to its efficiency, both in the quality of light and the solution of attaining the best light at the least cost commensurate with its efficiency.

The nature of the Moore light is rather inaccurately expressed by the words "vacuum tube lighting." Strictly speaking, a vacuum is a space void of all ponderable matter, and the tubes which are used in the Moore light contain small quantities of matter in the gaseous state. The basic principle of the Moore light is

defined in the most elementary books on electricity, wherein it is stated that air of the ordinary density—that is, under the ordinary atmospheric pressure—is a non-conductor of electric currents, but if the density be reduced to a sufficient degree, the resistance is reduced to such an extent that it may be considered a conductor. The passage of an electric current through rarefied gas causes it to glow. The old familiar tube known as the Crooke's tube exemplifies these facts.

The Moore light of the present time is simply a glass tube of convenient diameter and of any desired length, having electrical conductors hermetically sealed into the opposite ends and

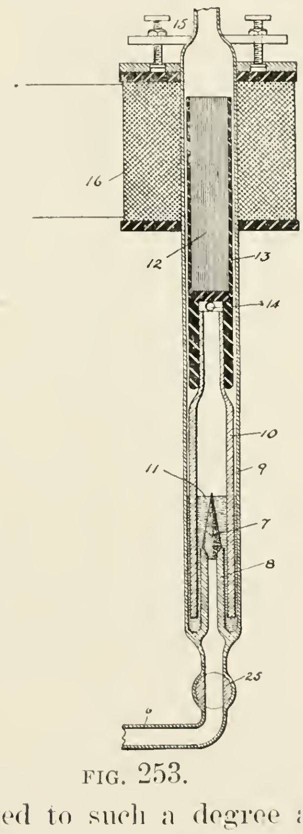


FIG. 253.

the air within exhausted to such a degree as to bring it to the point of conductivity for electric currents of available pressure. The passage of the current raises the rarefied gases to a state of incandescence. Any one wishing to produce a Moore light on a small scale can do so by finding a discarded incandescent electric lamp from which the air has been improperly exhausted, and passing the discharge from a spark coil through it.

As before stated, this light consists essentially of a glass tube having electrodes at opposite ends and containing ordinary air highly rarefied. With the continuous passage of an electric current, however, the air becomes gradually more rarefied on account

of electrolitic action of the gases in contact with the electrodes. This increases the rarefaction, and, as is well known, beyond a certain density any further rarefaction increases the electrical resistance. Provision must, therefore, be made for maintaining this resistance at a practically uniform point; in other words, of admitting air to the tube in extremely minute quantities and at regular intervals so as to maintain a constant pressure of the inclosed air. This is really the crux of the whole matter. To accomplish this a check valve has been invented which is practically frictionless and indestructible and so delicate in operation as to be sensitive to a difference in pressure of 1-40,000 of an atmosphere.

This statement sounds like a perpetual motion inventor's formula, but a glance at the mechanism shown in the diagram will at once convince the reader that these seemingly impossible conditions have been accomplished (Fig. 253).

The regulating apparatus is connected at 6 with the vacuum tube; 7 is a cone of carbon or other slightly porous material tightly joined to the tube 8. Around this is an annular space filled with mercury, 11. Into this annular space is dropped a glass tube, 10. By properly adjusting the quantity of mercury the tube or displacer, 10, will cause the mercury to completely cover the cone or leave the tip bare, according as it is raised or lowered in the mercury. If the tip is left bare a minute quantity of air will filter through the porous carbon and so enter the light tube, but once the cone is covered with mercury again the air is perfectly excluded. The only friction in the operation, therefore, is that of the glass tube in contact with the liquid mercury, which may be considered nil. The regulation is effected by connecting the displacer, 10, to the core of a solenoid, the solenoid being connected in series, or in any other effective way with the current used to generate light, and so arranged that any decrease in resistance will cause a lowering of the mercury and a consequent laying bare of the carbon cone, thus admitting air to the tube which will restore again the normal resistance. The slight movement required to perform this regulation is the only movement in the entire apparatus.

The only other apparatus required is a small transformer to produce a sufficiently high electromotive force to pass the current through the necessary length of tube. This may be installed at any convenient point, but is usually placed at the ends of the glass tubes.

An installation in an average room consists of a continuous glass tube, about the size of one's wrist (1¾ inches diameter) supported by simple fixtures on the four walls or ceiling at about

the height of the picture molding. and, therefore, out of the direct line of vision.

The alternating current from the street mains, ordinarily used for incandescent lamps, operates this light, or when direct current is the source, a motor-generator is utilized.

The intensity of the light can be regulated from a faint glow to 20 or more candle-power per foot, which produces an extremely brilliant illumination, yet with the great advantage of low intrinsic intensity, a condition which is recognized as ideal by the highest authorities on illumination. The eye suffers no inconvenience whatever.

No one will contend that there is any better light under which

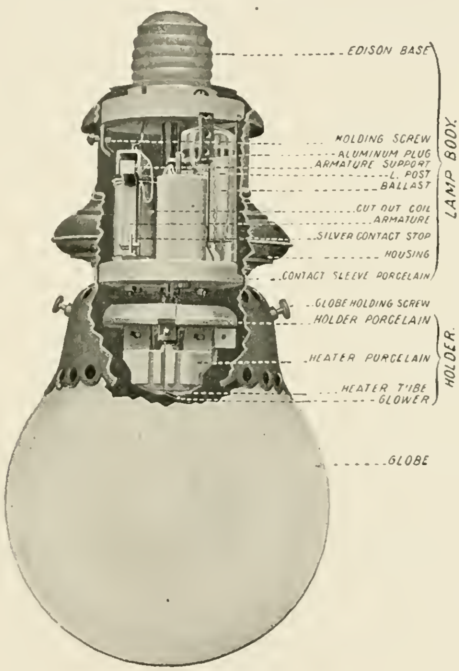


FIG. 254.

to perform an operation than the light of day. and since the tube really perfectly imitates natural light. it is, therefore, the ideal artificial light, not only so far as diffusion is concerned, but also as regards color. A wound, for example, will not take on a new appearance every time as when the bracket supporting the incandescent lamps is swung to a new position, but will always present the same shade to the operator. Further than this, tissues of all kinds, blood clots and so on, will have their own perfectly natural daylight color values and not be unnaturally distorted as with the present forms of light. Furthermore, the heat of the operating room is not only comfortable to the operator, but has a marked effect also on the patient. When the tube is used this heat is

reduced 80 per cent; that is, in direct ratio as the cost of the electric current is reduced. This saving is not quite as great if the tube is required to shed a white daylight color as distinguished from a yellow sunlight color.

Should this form of light fulfill the expectations which may reasonably be deduced from its present performance, the question of illuminating will be vastly simplified. To use Mr. Moore's striking expression, "Lighting will simply be a matter of glass plumbing."

OTHER FORMS OF LIGHTING.

The Nernst Lamp for illumination differs from all forms of electric light inasmuch as it does not depend upon a vacuum. This form of light has for its illuminant a glower, or a number of

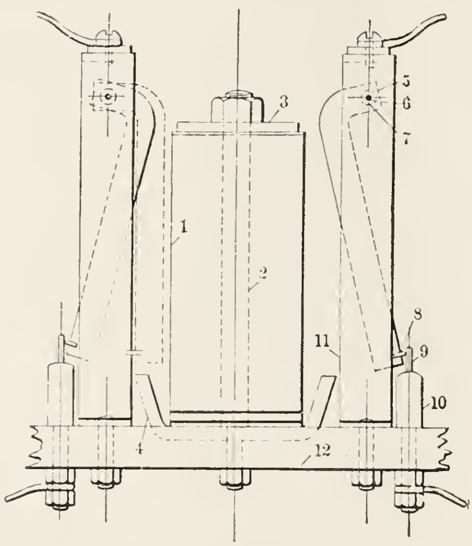


FIG. 255.

these about 1 inch long and 1-32 inch in diameter. These glowers operate in the open air and possess the peculiar property of being insulators when cold and conductors when hot, hence they must be heated before they will conduct electricity sufficiently well to maintain themselves at a light-emitting temperature.

The heating of the glowers is accomplished by heating tubes made of platinum which are heated by the current of electricity. The operation consists in the current passing through the heater, bringing it to a white heat: the proximity of the glower to the heater results in the glower becoming a conductor (Fig. 255). A cut-out coil becomes energized by virtue of the glower current passing through it; an armature of the cut-out which had heretofore closed the heater circuit is attracted; and this opens the heater

circuit, leaving only the glowers in operation until the next time that the lamp is turned on (Fig. 256).

It is claimed for this lamp that it has high efficiency, beautiful quality of light, that it is not subject to pulsation in voltage, has an ideal distribution of light, and a notable absence of shadow from the lamp itself. The light must be placed well above the line of vision, preferably at the ceiling, so that the light is thrown downward.

There has been devised a combination of the Welsbach and Nernst lamps. In it are utilized the principles that the higher the temperature of the incandescent body the higher will be the efficiency, as the visible part of the spectrum increases with temperature. The invention consists in passing an electric current

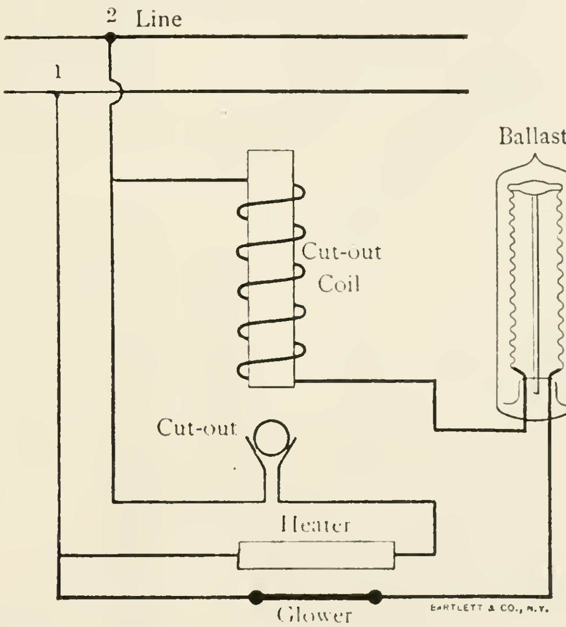


FIG. 256.

of suitable strength and voltage through the incandescent body, which is already heated by the ordinary Bunsen flame, so that the body heated by gas receives an additional rise of temperature by the passing of the electric current, whereby the production of light will be increased accordingly.

As an example of lighting some ten to twenty years ago the following, taken from the *Illuminating Engineer*, is of interest:

When the plans were formulated for the lighting installations for the operating pavilions to be built for the two public hospitals of Hamburg, a number of men were chosen from the office of the Inspector of Electric Illumination to decide upon the method of illumination. Measurements of the illumination in the old Pa-

vilion of the Eppendorf Hospital made with a Kruss illuminometer showed an intensity of about 170 meter candles at the height of the operating table (one meter above the floor). This illumination was furnished by the use of ten 32CP carbon filament electric

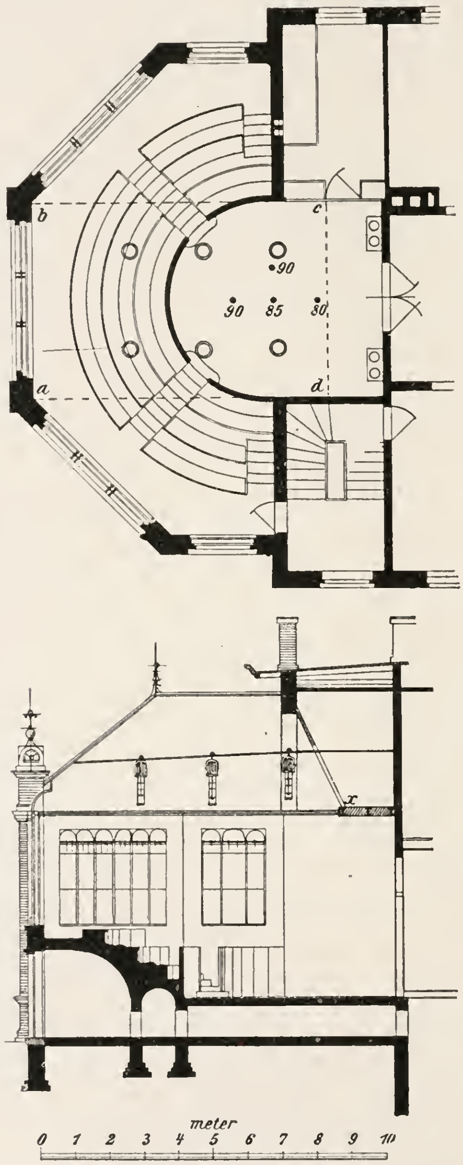


FIG. 257.—OPERATING PAVILION IN THE EPPENDORF PUBLIC HOSPITAL.

lamps fitted with a silvered reflector, and placed at a height of 2.3 meters, or a distance of about one meter above the table. This method of illumination, however, developed various disadvantages. The great amount of heat projected from the reflector above their heads was found very annoying by the surgeons; the effect being more and more perceptible as the operation continued. Another

and greater disadvantage was in the intense shadows cast, in consequence of the light source being concentrated into a single space, which was exceedingly troublesome, especially in the case of postmortems. Besides this reflector arrangement, table lamps were often necessary. From wide experience the following requirements were made for the new illuminating apparatus to be provided:

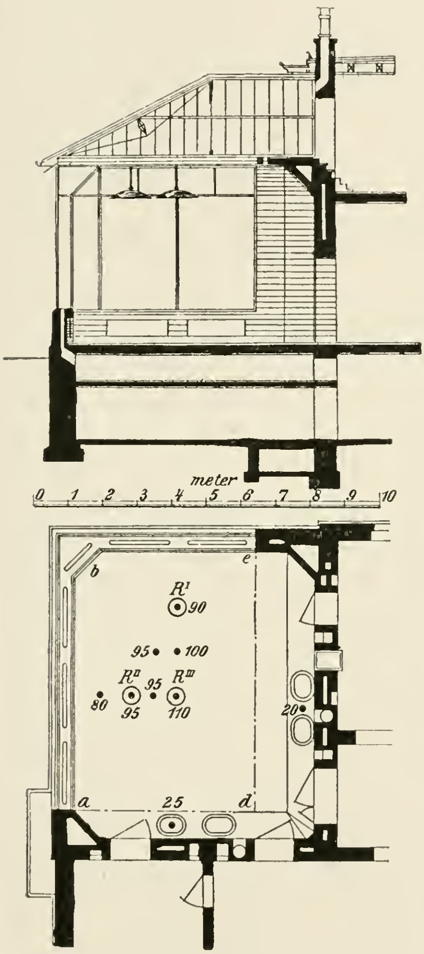


FIG. 258.

Large operating pavilion in the St. George Public Hospital.

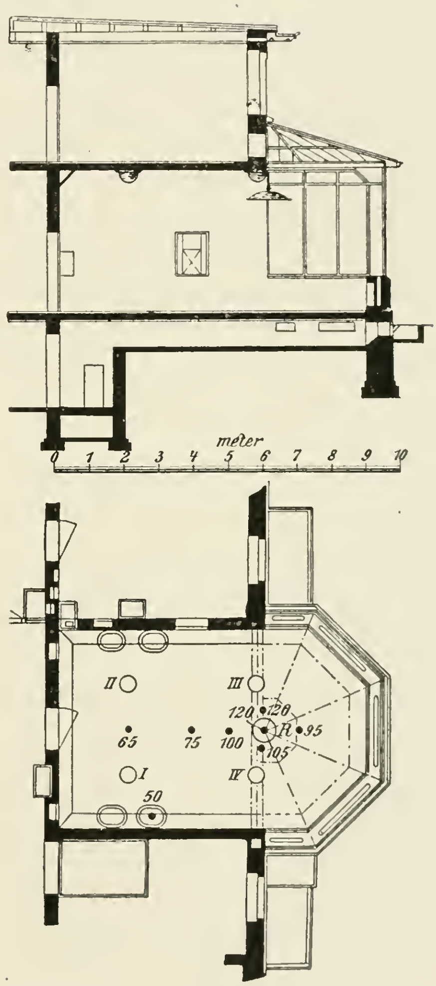


FIG. 259.

Small operating pavilion in St. George Public Hospital.

First—A high intensity of illumination.

Second—The greatest possible degree of diffusion.

Third—A minimum radiation of heat.

Fourth—A perfected method of arranging the illuminating units so as to offer the least possible opportunity for the collection of dust.

Fig. 257 shows the new operating pavilion of the Eppendorf

hospital in plan and elevation. The pavilion is in the front part of the general operating room; adjoining it, and separated from it by a hand rail of about one meter in height, is an auditorium of amphitheater form. As may be seen from the figure, the large extent of window service gives superb daylight illumination. In addition to this, the room is fitted with a skylight, which is furnished over the operating pavilion with a ceiling of obscured glass, as indicated by the dotted line, ABCD.

The artificial illumination is produced by six 15 amp. direct current arc lamps. These are suspended above the glass ceiling from rollers running on slightly inclined bars, so that they can be drawn into a position above the operating table by means of wire cables attached to them. Experiments showed that the best illumination was obtained when the lamps were used open—i. e., without glass shades. Besides giving the greatest amount of illumination, this arrangement has the advantage of preventing the shadows which would be thrown upon the glass ceiling by the wire netting, globe-holder and glass globe. The lamps are ingeniously arranged so that the unavoidable shadows of the carbon holders fall in the direction of the frame work in the glass ceiling. The stations at which measurements were made of the illumination on a horizontal plane at about one meter in height in the space about the operating table, are indicated in the diagram; the corresponding numbers showing the illumination in meter candles. Although the intensity of about 90 lux which was secured in the old operating pavilion is far from being reached, the diffused illumination now obtained fully answers the requirements. Long experience shows that a uniform illumination is far superior to a considerably stronger, but less uniform intensity.

The large operating pavilion of the St. George Hospital is shown in Fig. 258. In this case the placing of the light-source over the glass skylight is impossible on account of the construction of the roof, so that the artificial illumination had to be furnished from illuminating apparatus within the pavilion itself. For this purpose three reflectors were used, one over each of the operating tables, and the third in the center of the room to give general illumination. The focus height of the reflectors is four meters, so that the operator experiences no annoyance from the radiation of heat. Each reflector contains twenty-one 32CP Osmium lamps, and in order to give uniform distribution of light is covered on the bottom with a disc of frosted glass. The Osmium lamp was chosen, not only on account of the saving in current, but also on account of the smaller radiation of heat, and the whiter light which it produces. All angles, and attempts at decoration on the re-

flectors, which might collect dust, were avoided. The illuminating units are furthermore constructed with a regard to the necessity of spraying the walls and ceiling of the pavilion; the requisite openings for ventilation suitably protected from the spraying being provided.

The values of illumination given were obtained at the stations as shown in Fig. 258, the locations being along the side walls of the pavilion over the wash tables. The measurements were made after the pavilion had been fitted out with the necessary apparatus, such as operating tables, wash tables, instrument cases, etc.; the installation having been in use for some time, the candle power of some of the lamps had become reduced. The small pavilion in the St. George Hospital is shown in Fig. 259. In this case, also, the ceiling construction was such that it was necessary to place the illuminating units within the pavilion. A reflector similar to the one in the old pavilion is placed 3½ meters above the operating table. For the general illumination, 4 bowls of diffusing glass, each containing six 32CP Osmium lamps, were placed on the ceiling. The illumination obtained is shown in Fig. 259. It will be noted in regard to the wiring that steel conduits were placed above the ceiling with the switch placed in the corridor. The requisite sockets and plugs for connection with hand lamps and surgical apparatus in the operating pavilion are placed in nickel-plated boxes, the covers of which are attached to the wall. The walls and ceiling are covered with white tiling; the doors are of white enamel; the windows are of obscure glass, and the floor covered with shiny material, so that the reflection from the walls and ceiling increases the illuminating effect.

Besides the pavilion of the general operating rooms above described, operating rooms are also provided in the separate wards, in which minor operations are performed. In one of these, the illumination of which was provided in accordance with the demand for high intensity, there is much complaint on account of the heat radiation from the reflector. The illumination is provided by a silvered reflector containing three 25CP carbon filament lamps at about 2.3 meters above the operating table, and a wall bracket placed above the wash table. The illumination about the operating table, at a height of about one meter above the floor, is from 75 to 125 lux, and over the wash table, 35 lux. These high intensities are largely due to the fact that the voltage runs from 112 to 115, instead of the normal, 108. Furthermore, the reflector was new. The disadvantages of the formation of shadows mentioned at the outset as a result of an illumination from a nearby source, were very conspicuous in this case.

HYGIENIC.

Gas.—Dr. Beardsley says, in discussing the hygienic effect of gas lighting, that "In coming to the question of the effect of combustion products of gas upon health, it has sometimes been claimed that acetylene and carbonic oxide were among these products. Experiments by careful investigators have uniformly failed to show the presence of acetylene. In regard to carbonic oxide, some experimenters have been unable to find any, while others claim to have detected traces. The insignificant amount of the latter is shown by the following calculation: In a room 12 ft. wide, 16 ft. long, 10 ft. high, having three changes of air per hour and lighted by a gas jet burning 6 cu. ft. per hour, the quantity of carbonic oxide has been claimed would amount to about 1 part in 3,000,000. As the amount required to produce symptoms of poisoning, even after several hours of exposure, is 1,500 parts in 3,000,000, the matter cannot be considered of importance. Sulphur dioxide in almost infinitesimal quantities is also produced by a gas burner.

A cubic foot of gas requires for its combustion the oxygen contained in 6.02 cu. ft. of air, and forms in burning .82 cu. ft. of carbonic acid and 1.15 cu. ft. of water vapor. A flat flame gas burner consumes about 6 cu. ft. an hour. A Welsbach burner gives about three times the light with a consumption of 3.5 cu. ft. per hour, a little more than half that required for a flat flame.

Regarding the amount of carbonic acid in the human breath, probably the most accurate figures are those obtained in the respiration calorimeter experiments, conducted at Middletown, Conn. From these experiments it was found that the amount of carbonic acid exhaled varies greatly, according to the amount of work a man is doing. A man sleeping produces about .48 cu. ft. per hour, one exercising moderately about 4 cu. ft. In the ordinary living rooms a man seated will exhale about .76 cu. ft. of carbonic acid per hour. In addition organic matter of bad odor is also evolved both by lungs and skin.

It is to be noted that the carbonic acid produced by burning gas is accompanied only by water vapor and some insignificant amounts of sulphur compounds. The carbonic acid from human beings, however, is accompanied both by water vapor and organic impurities from the lungs and skin. This is an important fact, because, startling as it may sound, carbonic acid itself has no poisonous or injurious effect on the system. Regulations as to the amount of carbonic acid permissible in the air of a room are made because it is found that the organic impurities and the carbonic acid given off from the body bear a regular proportion to

each other. It is difficult to directly determine the amount of organic impurities present, but if the amount of carbonic acid is learned, the organic impurities are known by inference. The statement that carbonic acid itself is not at all harmful is, of course, contrary to the older belief, but it is the conclusion of the best investigators.

It appears that we may not attribute a sensation of close or bad air in a room to an excess of carbonic acid. Authorities tell us also that any ordinary diminution of the per cent. of oxygen present cannot account for it. The cause seems to be something quite different. Investigators lay it to three factors. The first, though not the most important, is unpleasant odors. The effect of these is mental rather than physical, but very real nevertheless. But the two most important causes of closeness are high temperature and excessive moisture, particularly the latter. Temperature and moisture are related to each other in the fact that with a high temperature more moisture is allowable and necessary than with a low temperature. A certain balance between the two, or a per cent. of saturation, is necessary for health and comfort. The removal of moisture from the body by insensible perspiration and by the breath will be unduly hastened or hindered, as the case may be, according as there is a lack or an excess of moisture in the air. An excess of moisture, however, appears to be most often responsible for discomfort.

Since water vapor is one of the products of the combustion of gas, we are at once met by the question: What is the effect of gas lights upon the moisture in a room? A certain amount of water vapor, as said, is necessary for health and comfort. Authorities say about 50 per cent. of that required to produce saturation of the air is the proper amount. It is only in the summer time that the air of our houses as drawn in from outside, contains that amount. As soon as fall comes and the furnaces are started, there is the usual complaint of the excessive dryness of our rooms, and water is often purposely evaporated to supply the lack. It is only in the summer, therefore, that the moisture from the gas flame would be undesirable, and in the summer time our houses are as open as it is possible to make them. With air pouring in through every door and window, the moisture added to the air by a gas flame is indistinguishable. During the rest of the year the addition of moisture by gas is not only not an annoyance, but a benefit.

It may be said that it is anything but the object of the writers to undervalue the importance of good ventilation. That is a matter of which experience has shown the necessity, irrespective of the

question of lighting. It does appear, however, that efforts to show the poisonous character of the products of the combustion of gas lack corroboration by the best scientific investigations.

It is claimed for acetylene that its vitiating effects are only about one-eighth those of coal gas, and that its heating property is very slight.

The hygienic effects of electrical lighting need no special mention. There are no odors, and no carbon dioxide or other gases in this form of lighting. The heating effect of such lighting in all its forms is of no consequence so far as hygienic effects are concerned, for this is the dry heat of radiating surfaces and not the direct heat of combustion.

CHAPTER XXIII.

REFRIGERATION.

There are two processes of obtaining refrigeration—natural and artificial. In the former the necessary cold is produced by melting ice, while the latter is produced mechanically. The natural method need only be mentioned as a process without special apparatus.

The ordinary ice box or refrigerator is familiar to every one. In hospitals it is usually necessary to have special boxes built, depending wholly upon the size of the institution. The building of such boxes follows the same rules as those for artificial refrigeration—the only difference in the boxes or rooms being in the method of obtaining low temperatures. In either process a general refrigerator large enough to take care of the supplies for the hospital is ordinarily put somewhere in proximity to the kitchen department. In the diet kitchens there are placed small boxes to take care of local supplies. In cases where cold storage is required, special rooms are built for this purpose.

The essential in either system is the same—namely, that refrigeration is the withdrawal of heat. Whether this be done by the melting of ice, as in the natural process, or by one of the methods of artificial refrigeration, the process is primarily the same.

Natural ice for hospitals has long been condemned as an agent for preserving foods any length of time. The time has passed for attempting to hold foods by means of ice, as it is impossible to maintain a sufficiently low temperature and dry atmosphere to do the work. Different classes of foods require different temperatures, which cannot be secured by the use of ice; but by mechanical refrigeration temperatures may be perfectly controlled.

The advantages of mechanical refrigeration are daily becoming better known and appreciated, and it has become indispensable to a great variety of industries as well as to every household. It makes possible the preservation of food products, supplies pure, hygienic ice at all times, and forever does away with the lodgment of poisonous germs which accumulate in wood or metal lined

refrigerators that become water soaked and soggy from melting ice.

Dr. Ross says: "The two questions of most interest to institutions are the manufacture of ice and the storing of food. To determine whether it is advantageous to manufacture ice, many questions must be taken into consideration. If the supply of water from which natural ice is frozen is bad, or the facilities for obtaining it difficult—such as exists in our more southern cities—it is probable that a much more wholesome and cheaper product can be obtained by artificial refrigeration. In a table published in a recent book on artificial refrigeration, after making a proper allowance for engineers, laborers, coal helpers, oil, operating expenses and sundries, it has been determined that with a machine which will make one ton per day the ice will cost $4.25 per ton; with a two-ton machine, $2.50 per ton; with a four-ton machine, $1.88 per ton; a six-ton machine, $1.51 a ton; a ten-ton machine, $1.37; with a one-hundred-ton machine, $0.62. These figures must necessarily vary with the cost of fuel, labor, etc. Coal on the above estimate has been figured at $3.00 per ton, and the engineering help as having no other duties. In a small plant the expenses of engineering could probably be eliminated, as this work could be combined with other duties without increasing the cost.

Some of our large cities, in the neighborhood of which it is difficult to obtain pure water supply and pure ice, are placing such restrictions about the ice business as will have a tendency to make the manufactured article more popular. Natural ice, from a certain source, may at the beginning of a winter season be pure, so far as analysis can show, but later in the season, when the frozen earth prevents filtration, the surface water readily finds its way to the larger body of water, there forms into ice, and shows every evidence of contamination.

One of the ordinances of Chicago requires that all ice to be delivered within the city for domestic use shall be pure and healthful. Healthful ice is defined as "ice which upon chemical and bacteriological examination shall be found to be free from nitrates and pathogenic bacteria, and to contain not more than 9-1000 of one part of free ammonia and 9-1000 of one part of albuminoid ammonia in 100,000 parts of water. Water for ice should be prepared as stated below.

For the preservation of perishable goods, the temperature is the chief factor, but other conditions, such as clean, dry, well-ventilated rooms and pure air, are at times almost of equal importance. Humidity is of almost as much importance as temperature at times. Extreme cold temperature will affect certain

articles in such a way that when removed from cold storage they quickly deteriorate. The methods by which articles pass from cold storage to the consumer are of such importance that the quality of the article is greatly influenced by them. A cold storage room should not be too dry, for if so, it will favor the drying out of the goods and their shrinkage. If the moisture is kept below the point of saturation the best results are obtained. Proper ventilation will safely regulate these conditions. A good method is to force the air over the cooling pipes into the cooling room; the air should always be admitted at the top of the room.

Meat rooms and rooms used for the storage of other articles of diet should be periodically cleaned and disinfected; formaldehyde gas is easily applied and very efficacious."

Mechanical Refrigeration.—There are two ammonia systems now in use, the absorption and the compression systems. It is very generally conceded that the compression system for practical purposes is by far the better. The medium used as the refrigerant is anhydrous ammonia. There are other systems using other refrigerants than ammonia, such as carbon dioxide, sulphur dioxide and air, but there are really so few machines of this type in actual operation that they are hardly to be considered.

Anhydrous ammonia boils at about 28½ degrees below zero F. when under atmospheric pressure. At temperatures below this it is a liquid, while at temperatures above—and this includes the ordinary range of storage temperatures—it is a gas. It is this low boiling point that makes it a good refrigerating agent. When allowed to evaporate it takes up heat in the process. Every pound of ammonia during evaporation is capable of taking up a certain quantity of heat. Were it not for the expense for ammonia, the compressor might be done away with and the ammonia after evaporation allowed to escape into the atmosphere. To reconvert the gas to a liquid and remove the heat which has been absorbed in the evaporation is the function of the refrigerating machine.

There are three processes necessary in the compression system of refrigeration—namely, compression, condensation and expansion of the cold-producing agent, which three form a continuous cycle. These processes are accomplished by machinery and appliances especially adapted to each. The compressor is simply a pump specially designed for the purpose of compressing the ammonia gas and forcing it into the condenser under pressure. The condenser is a series of continuous pipes confining the gas under pressure while subjected externally to a constant flow of cold water. The expansion coils are continuous coils of pipe into which the

liquid ammonia is allowed to expand through a small orifice in the expansion valve. This liquid expands about 1,500 times its volume, and in so doing absorbs heat from the surrounding atmosphere or brine, as the case may be, thus producing intense cold. The expansion coils are connected to the suction pipe leading back to the compressor, and thus the gas returns to renew its cycle.

From the above it will be seen that the heat absorbed by the ammonia is in turn absorbed by the cold water circulating around the compressor cylinder and through the condenser. The ammonia, then, is simply the agent by means of which a comparatively high temperature in the water produces a low temperature in the rooms or boxes to be cooled.

The ammonia is not used up in the process of refrigeration, but travels from the condenser and compressor to the expansion coils and is then pumped back, in a continuous cycle. The expense for ammonia is limited to that which escapes from the system through leakage and will depend upon the care and attention given by the operator.

There are three practical methods of producing temperatures desired in cooling rooms, boxes or tanks in the compression system—namely, direct expansion, brine circulating, and air circulating systems.

Direct Expansion.—In this system the liquid ammonia is allowed to expand in pipes placed in the rooms to be cooled and in process of expansion absorbs the heat in the rooms to be cooled.

Brine Circulating.—Instead of being placed directly in the rooms to be cooled the expansion coils are placed in an insulated tank of brine. The expansion lowers the temperature of the brine, which, of course, remains in a liquid form at temperatures far below the freezing point of pure water. This cold brine is then pumped through pipe coils in the rooms to be cooled, and returns to the tank to be used again.

Air Circulating.—In this method expansion coils are placed in an insulated box, or room, through which the air is drawn to be cooled by passing over coils and distributed to the cooling rooms, returning thence through ducts to the pipe room to begin the circuit again.

The three systems of refrigeration—the direct expansion, the brine and the air circulating—are each especially adapted to certain uses. The direct expansion is more largely used than the others, as it is installed at less expense, and lower temperatures can be obtained.

The brine system, although more expensive, is often more advantageous under certain conditions. For instance, where it is

desired to run the compressor only a part of the day, the brine pump is kept running, thus circulating the cooling fluid. Also where there are many small rooms or boxes to be cooled it is difficult to control the temperatures with the small amount of piping in each room and a separate expansion valve, but with the constant circulation of the brine the temperatures are perfectly regulated.

The air system is used in comparatively few plants at the present time. In using this system it is necessary to run continuously. It is not well adapted where a very low temperature is required, but an even temperature and dry atmosphere can be successfully maintained.

Capacity.—Refrigerating capacity is measured in the cooling effect of melting one ton of ice. A ten-ton refrigerating machine, when operated twenty-four hours daily, does the same amount of cooling as would be produced by melting ten tons of ice. In selecting the size of machine required for any plant, it is necessary to get one large enough to do the work when the maximum cooling is demanded. For this reason it is best to have a machine much larger than the average consumption of ice. For cold storage purposes, or for work where the demand upon the machine is constant during the entire twenty-four hours, a three-ton machine will take the place of three tons of ice. But if three tons of ice are needed in six hours, it would require a machine four times as large, or twelve tons.

It is, of course, possible to store up a part or all of the cooling energy of the plant for use when required.

There are refrigerator boxes arranged to permit the machine to be operated only a part of the time and still maintain a uniform temperature in the boxes, as shown in illustration (Fig. 264).

The question naturally arises what is the cost of mechanical refrigeration? The operating cost is practically just that of the power required to run the compressor, and this is very slight. The machine is generally run only when the rest of the machinery is operated, and, therefore, requires very little additional time or attention.

Ice Making.—Of the many systems that have been devised for the manufacture of artificial ice, there are but two now in practical use: First, the can system. Second, the plate system. The can system is the one most extensively used, the ice being produced in galvanized iron cans immersed in salt brine, kept at a temperature far below the freezing point of water by the evaporating properties of ammonia, through coils submerged in the brine.

Evaporating coils in the smaller sizes are usually made in oval form of continuous pipe, having no joints except where connected to headers at top and bottom. Liquid ammonia is admitted to the upper header by an expansion valve, and evaporates from this bath of liquor into the several coils. The lower header, called the gas header, is in connection with the suction side of the compressor, and hence serves to assemble the gas for transmission to the machine. Here it is compressed, sent to the condenser, liquefied and deposited in the receiver ready for use again. The coils are contained in an iron or wooden tank, well insulated. The galvanized iron cans, which contain the water to be frozen, as before mentioned, are immersed in the brine, and a coating of ice soon forms on the inside, and after a lapse of time, according to the size of the cans, solid blocks of ice are produced.

Transparent ice is obtainable by a complicated process of distilling the water by passing steam through a condenser, skimming off the impurities, reboiling the water, cooling it, and then putting it into the cans—then freezing it for a period of 48 to 60 hours.

The same machine is used to produce ice that is used for refrigerating purposes, but it must be borne in mind that a five-ton refrigerating machine will not produce five tons of ice. Refrigerating machines are rated in tons refrigerating capacity, and by a ton is meant, as stated, the cooling effect equivalent to the melting of a ton of ice in twenty-four hours.

The ice-making capacity is less than the refrigerating capacity, because of the fact that the water must be cooled from its initial temperature to 32 degrees F. before freezing starts. In addition to this the freezing tank must be refrigerated, which requires refrigeration equal to cooling a box of that size to 32 degrees. In consequence the ice-making capacity is from one-half to two-thirds the refrigerating capacity.

Insulation.—The proper insulation of buildings for cold storage is a matter of greatest importance if ultimate economy is to be considered. Without good and heavy insulation greatly increased refrigerating power must be used. It may be possible to produce and maintain low temperatures in poorly insulated rooms, but in all cases it is done at the expense of extra fuel. Hence we see that insulation is a vital point in refrigeration and careful study should be given both to the materials used and to the method of constructing walls. If it were possible to construct a perfectly insulated room for cold storage, the refrigerating machine would have but little to do after the temperatures were once produced, except to abstract the heat from foods when they were first put into the rooms.

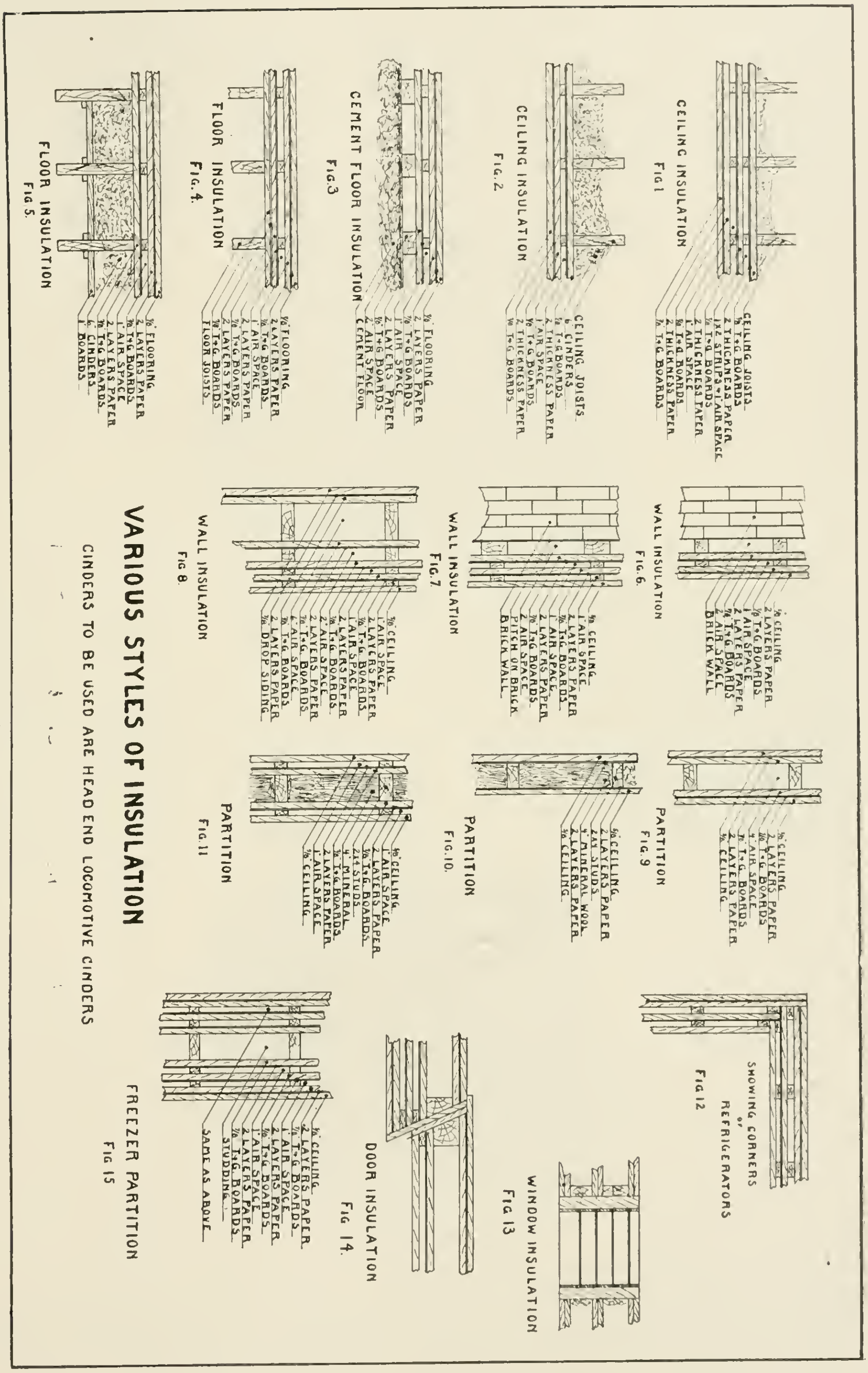

VARIOUS STYLES OF INSULATION
CINDERS TO BE USED ARE HEAD END LOCOMOTIVE CINDERS
CEILING INSULATION Fig 1
CEILING INSULATION Fig. 2
CEMENT FLOOR INSULATION Fig. 3
FLOOR INSULATION Fig. 4.
FLOOR INSULATION Fig 5.
WALL INSULATION Fig. 6.
WALL INSULATION Fig. 7
WALL INSULATION Fig 8.
PARTITION Fig. 9
PARTITION Fig. 10.
PARTITION Fig. 11
SHOWING CORNERS of REFRIGERATORS Fig 12
WINDOW INSULATION Fig 13
DOOR INSULATION Fig 14.
FREEZER PARTITION Fig 15

FIG. 260.

No definite rules can be given for proper insulation in the construction of buildings or boxes, as conditions are so varied, but in any case solid walls, especially of brick or stone, must be avoided. Solid walls or partitions are continuous conductors of heat and moisture. Many times architects have built solid walls instead of walls having air spaces, and then wondered why frost or dampness should appear on the inside of the building. Dead

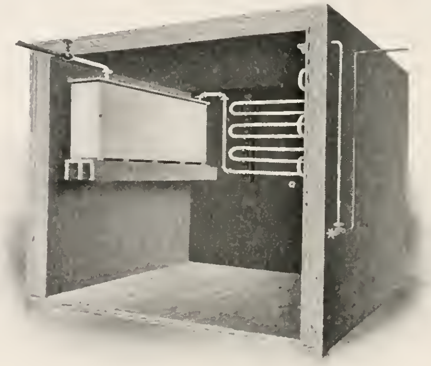


FIG. 261.

air spaces, filled spaces, tongued and grooved boards and insulating paper are essential to satisfactory insulation. Care should be taken in selecting the paper for insulating purposes. Porous, spongy paper will not do the work. Choose a well-known brand, manufactured by a responsible firm. The paper should be durable, water-proof, vermin-proof, non-combustible and odorless. Care must be taken to make all openings, such as doors and windows,

FIG. 262.

as nearly airtight as possible. The doors should be light and with the edges fitted to overlap the jambs. Windows should be few, but, where necessary, made triple glazed. For entrance to all rooms an anteroom should be provided, if possible.

Fig. 260 shows in detail various methods of insulation. Some show how to adapt insulation to old walls of brick, stone or wood;

others how to construct new walls. Some show methods of construction that might be used when initial expense must be considered in spite of subsequent losses.

Refrigerator Piping.—The illustrations show five methods of piping refrigerator boxes. In cases where a uniform low temperature is desired and the machine is not to be operated twenty-four hours per day, Figs. 261, 262 for direct expansion and Fig. 263 for brine circulation is advised. Fig. 261 is similar to Fig. 264,

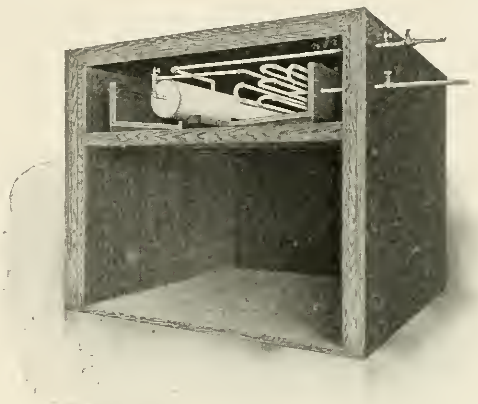


FIG. 263.

except that a rectangular tank, holding several hundred pounds of brine, is placed on the side of the room. The ammonia circulates through the exposed coils first and then through the coils submerged in the brine. At the end of each daily run the brine is cooled down to zero or a little above, thus storing sufficient cold

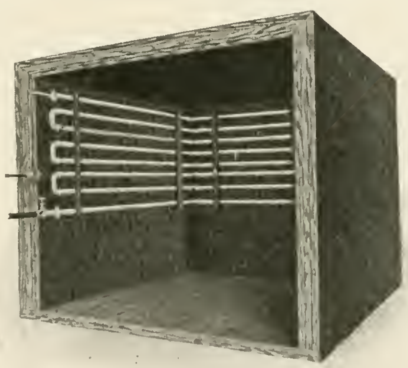


FIG. 264.

to maintain a low temperature while the machine is shut down. The success of this system depends upon the thorough insulation of the refrigerator walls.

In Fig. 262 the coils and tank are placed in a loft, the air circulating up a flue at the left, then across the brine tank through the

coils and down again to the room through a flue at the right. This gives a very dry atmosphere as well as low temperature.

Where ice is to be made the plant should preferably be run twenty-four hours, in which case the room for storage is equipped as shown in Fig. 265.

Fig. 263 consists of coils and closed brine tank through which cold brine is circulated. The compressor, brine tank and all ammonia piping are compactly located in the basement, and the refrigerators are on the upper floors. The machine needs to be operated but from five to fourteen hours daily, depending on conditions, and there is no ammonia piping in the boxes.

The table given herewith is for approved cold storage temperatures, and will be useful in computing the temperatures required in any given space or in the whole box.

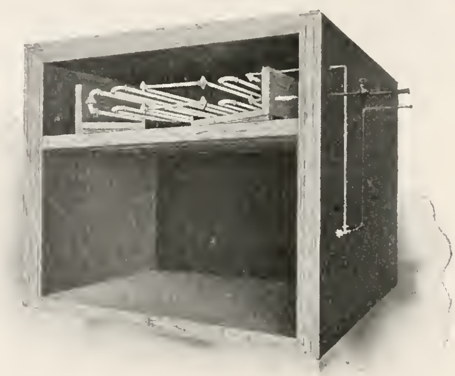


FIG. 265.

	Deg. Fahr		
Beef	36	to	40
Hogs	29	"	32
Lamb and Mutton	32	"	35
Veal	34	"	36
Meats, in pickle or brine	35	"	40
Butter (must be kept separate from other goods)	32	"	38
Eggs (must be turned occasionally)	32	"	34
Cheese	32	"	34
Lard	38	"	40
Poultry, to freeze	5	"	10
Poultry, when frozen	25	"	28
Game, to freeze	5	"	10
Game, when frozen	25	"	28
Fish	25	"	28
Oysters	33	"	45

Beer	33	"	42
Wines	40	"	45
Cider	30	"	40
Fruits	33	"	36
Vegetables	34	"	40
Canned Goods	38	"	40
Flour and Meal	40		

FIG. 266.

CHAPTER XXIV.

EQUIPMENT IN CONSTRUCTION.

Such equipments as are described in this section are constructive features of the hospital and must be provided for and built in as the building progresses. They consist of elevators, dumb waiters, vacuum cleaning systems and sterilizers. Shades and ranges are also included, as these require special attention.

Elevators.—There is no standard that can be established for the elevators in hospitals, as their pattern, the motive power, their location and their general use would all be factors in determining this.

Elevators in hospitals are divided into two classes, however, as they are in other buildings—namely, passenger elevators and what are virtually freight elevators, and which are for the use of patients when on the wheel chair or wheel stretchers. The only difference in these elevators is their size and their general equipment or difference in the cage.

All hospitals are not necessarily equipped with two elevators, as one large one is sufficient for the needs of institutions containing up to 100 or 150 beds. Beyond this limit it is somewhat inconvenient to use one elevator for patients and other passengers, and for the conveying of heavy supplies and linens. In such institutions the dumb waiters are not usually made sufficiently large or their machines of such power (often being operated by hand) to carry such articles as flour in barrel lots, nor can the cumbersome baskets of linen be conveyed in such dumb waiters. The wheel stretchers occupy so much space on an elevator, and in general hospitals it is necessary to take patients up and down so continuously for one reason or another, that when the limit of capacity is reached it is advisable to install two elevators—the smaller one for passengers and the larger one for stretchers and supplies. There is a decided advantage in this, because the larger elevator can be located so that it will serve both the operating and dressing department and also the store rooms and refrigerators for the kitchen department, without interfering in the least with the rest of the hospital; in other words, it can be more readily isolated so as to cause no disturbance, and still be handy enough to be accessible from all parts of the hospital. This then

leaves the passenger elevator for passengers only, and makes it necessary to use only such power as would be devoted to this continuous service, leaving the other elevator for the intermittent and heavier service.

Elevators are of several kinds and the type which is to be installed depends wholly upon the power available and the general conditions existing.

They may be classified as follows: Those operated by engines, either steam, gas, gasoline or electric, in which there is a drum at the machine placed in the basement, and the lifting cable runs up and over an overhead sheave or wheel and down to the drum; the direct lift elevator, in which the machine and drum are put directly over the elevator, usually in a pent house, this being applicable only to electric hoists; the hydraulic elevator, which is operated by a cylinder of proper length into which water is pumped; and the direct lift or plunger type of hydraulic elevator, which is operated by a piston, lifting directly under the elevator. There are also hand types operated by hand power by means of rope and wheel gearing.

All elevators have either hand or automatic control. Of the former there are the rope control and lever control, the latter being of two types in electric elevators—namely, the full lever and the magnet control. The automatic elevator is controlled by push button devices. This is known as the full automatic push button control elevator, and is especially designed for hospitals where no regular elevator operator is employed. The control of this elevator is interesting in view of the fact that it requires no operator. There is a push button at each landing. Pressing one of these buttons calls the car to that landing, where it stops automatically. On entering the car, the passenger finds a series of push buttons (one for each floor) and has only to press the one desired. The car then proceeds to that floor, where it stops automatically. While the car is running or while any shaft door is open, no one can interfere with its operation. Safety locks keep the doors locked except when the car is at the landing. Safety switches prevent the elevator from being started unless all doors are closed.

All elevators should be equipped with starting and stopping devices which give perfect control of the car. In these the speed of cutting out resistance should be entirely regulated at the machine; the lever on the car in these can be instantly reversed without causing the slightest damage, and are so arranged that when the operator removes his hand from the lever it will return to a central position, stopping the car in the usual way. This is

a safeguard which makes it imperative for the operator to keep his hand on the control at all times, and if he does not do so, the elevator comes to a full stop.

Elevator doors should be of the differentiating type, in which the door is divided into sections, all operating on lever arms, and in which the first section moves faster than the second, and the second faster than the third, in such a manner that when the first section is open, all the other sections are fully opened also. This door can be made to operate almost noiselessly.

Besides the elevators just described there is the inclined runway, which is admirable in some hospitals. In warm climates this can be put both in and outside of hospitals, and if made on a very gradual slope or on a double slope with spacious landings are better than stair runs in such hospitals. Naturally these could not be used in many storied hospitals.

Dumb Waiters.—These are of two types, those operated by machine, usually electric, and the hand power dumb waiter. The electric type should preferably be of the full automatic control, the same as described for the regular elevators, except that there are no buttons in the dumb waiter. A push of the button on any floor brings the dumb waiter to that floor, and by pushing a button for any other floor, the dumb waiter will go to that floor and stop.

There are also the rope control dumb waiters, which are run by electric or steam machines.

The full rope control, rope hand hoist dumb waiters, or as they are sometimes designated, hand-power-lifts, are operated entirely by hand, no machine power being used. These are counterbalanced and equipped so that they operate easily. Dumb waiters and elevators of this type are equipped with automatic brakes. These brakes should be supported independently of the rest of the machine, so that there will be no end thrust, strain or friction and unnecessary wear. The shafting should be of steel, and all bearings should be fitted with anti-friction steel bearings, of the pin or ball type, to make the apparatus easy running. The cars should be of ample capacity and supplied with strong shelves.

For high buildings, dumb waiters with band-brakes are preferable, so that the speed of the car can be controlled by the brake cord, and so that the car can be stopped and locked at any given floor.

Vacuum Cleaning Systems.—Modern methods in hospitals are superseding former and crude unsanitary ones. This is especially true of cleaning and scrubbing. Just as the common broom with its unsanitary raising of dust was replaced by the car-

pet sweeper, which removed only the surface dust and dirt, so the "vacuum broom" has replaced the carpet sweeper. The difference in the transition, however, is decidedly more marked in results. With the vacuum system there is no dirt or dust, this being entirely removed and conveyed to the basement and disposed of without the necessity of carrying it through the building as in the old methods of the dust pan, pail and carpet sweeper. Vacuum systems also remove the dust which was formerly brushed into the air by the old duster, only to settle again. The dusting cloth, shaken out of the window when possible was an improvement, but it was difficult at best to get at places somewhat above the ordinary reach to remove the dust except on "cleaning day," when a ladder or chair was employed.

In modern hospitals, owing to the necessity for ventilating rooms, there are always currents of air, which may not be perceptible to occupants of the room, but which are sufficient to stir up dust particles and keep them in floating condition.

Scrubbing and cleaning systems may consist of portable service, which is a cleaning system complete on wheels and is designed for buildings which are not equipped for cleaning devices. The combination compressed air and vacuum system, in which a heavy blast of air dislodges the dirt and the vacuum automatically removes the dirt to dust-arresting tanks. This apparatus is not ordinarily needed in hospitals, except in pipe and wire slots, and such places where dust is liable to accumulate for any length of time, and where it is not practicable to clean daily. A vacuum system consists of a vacuum pump or aspirator to obtain vacuum, the tanks for atomizing and condensing, the piping to carry the dust, and the cleaning tools and brushes. The pump can be driven by steam or electricity; if by steam it should have an automatic control. The cost of operating such a pump directly connected is less than one cent per sweeper hour. The electric driven pump can be either direct connected, chain drive or belt drive. The better grades of these pumps will operate a 15-inch vacuum.

The steam ejectors or aspirators are used only where there is no other power. They are operated by steam under pressure or by compressed air, but are not as economical as the power-driven pumps. The ejector or aspirator takes from three to five times as much power to operate to produce the same results as a vacuum pump. The apparatus is placed in the basement and the building is piped. The usual method is to run a sufficient number of risers up through the building with vacuum inlets on each floor, so that convenient lengths of hose reach all points. The size of these pipes depends wholly upon the capacity of the plant. The

joints in these pipes should be made with rubber gaskets and should be of sufficient size so that the system is permanent. In making turns or bends in the piping recessed, long turn fittings or recessed fittings with bent pipe should be used.

The most important factor in any cleaning system is the separation of the dust from the air. This is done in the tanks. The first or dry tank removes the larger percentage of the dust by centrifugal motion. The remainder or lighter particles are removed by atomizing in the "wet" tank. The air is passed through water in this tank, thus washing it and allowing it to pass to the pump thoroughly cleaned, the circulating water running to the sewer.

The tools consist of carpet sweepers, sweepers for hardwood and tile floors, wall brushes, clothes brushes, upholstery brushes. The scrubbing brushes are made to permit water to run into them through a supply hose, the water being under control, and as the floor is scrubbed, the vacuum mop, as it is designated, takes up the water. Corridor floors and floors of operating rooms especially could be done in this manner.

Sterilizers and Disinfectors.—The modern hospital is not complete without its sterilizing apparatus. There are many forms of sterilizers, from the large apparatus for surgical dressings to the smaller instrument sterilizers. The steam for sterilizers is derived from the boiler supply, and if there is no such general plant, a plant is installed for the purpose. In smaller hospitals where live steam is not available from a central point, it may be made for the sterilizers by a gas flame or petroleum flame. If steam from a central plant is obtainable it is used in the central disinfecting plant, to disinfect bedding; for sterilizing instruments in the operating department; in the dispensary, dressing and autopsy department; it is used also for the heating of thermostats and apparatus of the pathological laboratory and the water baths. It is also used in the kitchen, diet kitchens, in the steam jackets, coffee urns and other apparatus for cooking and keeping food palatably hot; and for sterilizing water under steam pressure. It will be evident that a central plant to supply all of these is an economy in many ways, as the sterilization could be done more quickly and readily if the steam were always at hand to turn on instantly.

For the operating department there is ordinarily provided a sterilizing room, in which are the surgical dressing and instrument sterilizers. These consist of a steam jacketed, pressure steam sterilizer of necessary size to do the work adequately. They are made in two forms—the globe form, being a ball-shaped appa-

ratus, and the long cylindrical apparatus. The globe form has a steam-tight door without mechanical catch or fastening, the door sliding or rolling back and forth, making a metal to metal joint when closed. It is free from all packing and gaskets, which is an advantage where such high temperatures are necessary. The cylindrical form has a swing door which closes into a rabbett, and has screw clamps to bring the door closely to the rabbett and which must be fastened securely. Instrument sterilizers are of two kinds, the oblong and oval, both of which come in various sizes and depths. They are usually of the shallow pattern or of medium depth with one or two trays. Bowl sterilizers are of the deeper form. There is usually one instrument and one bowl sterilizer placed in the sterilizing room. In each dressing room and in the obstetrical department there is also one, and sometimes two, instrument sterilizers.

It is not always possible to have a central distilling plant for obtaining sterile water, in which case a sterilizing apparatus under steam pressure, operated by steam, gas or petroleum, should be installed to obtain sterile water for surgical operations. Such sterilizers should have, in connection, a filter of the germ-proof stone form. The coils should be removable and the whole apparatus so constructed that it is not necessary to use wrenches to remove the covers.

Pathological laboratory equipment depends wholly upon the extent of the work to be performed by the institution in this line.

There are also steam sterilizers for Pasteurizing or sterilizing milk in large or small quantities. Such apparatus is necessary in all hospitals, but especially in children's hospitals and those hospitals having an obstetrical department.

Steam sterilizers are used in disinfecting ovens. These are of two forms, the rectangular and the cylindrical. They are used for sterilizing mattresses, bedding and clothing. The steam to these must be superheated, dry steam put into the ovens at high pressure, and the ovens must not be opened until they have cooled thoroughly, as opening before this takes place causes condensation and a consequent dampness of the contents of the sterilizer.

Disinfecting or fumigating as generally practiced is more or less of a farce. To be effective it may be done in several ways, but the method most in use now, and perhaps the only positive method, is by permanganate of potash and the formaldehyde gas process, and with this it is best to have an apparatus for generating the gas. There are several forms in the market.

It is an easy matter to test the efficiency of any one of these by placing in the room to be disinfected cultures of bacteria and

also dressings saturated with wound secretion containing pathogenic bacteria and making cultural tests of these after the disinfection has been completed.

KITCHEN EQUIPMENT.

STOVES, RANGES AND FOOD HEATING APPARATUS.

In former years when hospital kitchens were crude in their

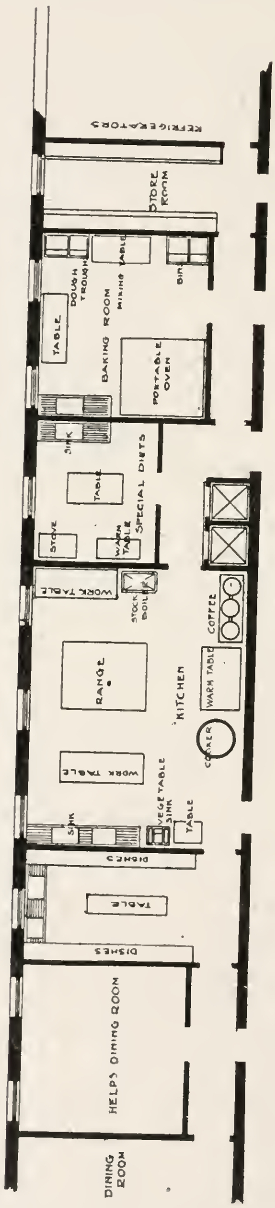


FIG. 267. Kitchen Department.

construction and more so in their equipment, the latter consisted of a large stove or range placed in a room, always in the basement, upon which were placed huge pots, kettles and pans, in which all

of the food was prepared, and the odors from which permeated and saturated the entire building for hours before and after each meal, in fact continuously. With the advent of the many-storied hospital this has been changed, and we now have the kitchen on the top floor, along with a diet kitchen which is also a training room for nurses in the art of preparing special diets. In addition to this diet kitchen there are the baking room and the auxiliary diet kitchens, one on each floor upon which patients are treated. This has brought up the serious problem of getting food to patients hot and palatable, and there has been consequent elaboration of equipment. In the general kitchen is placed the large range for cooking the ordinary food. Here also, in large institutions, are placed steam-jacketed kettles for cooking vegetables; and the steam-jacket serving table with its hot water pan, into which are placed crocks containing food; and also the closets for keeping dishes warm. This latter arrangement is so simple and can be run so inexpensively that it is somewhat surprising it is not installed more often (Fig. 267).

The baking room, which is separate from the kitchen, is supplied with a portable oven or ovens (depending on the size of the institution) with all the necessary equipment for baking.

The special diet kitchen is furnished with a range, or preferably a number of small gas stoves for preparing special diets.

The diet kitchens on each floor are fitted with a gas stove and a steam-jacketed warming oven, as described, and sometimes a coffee urn.

In some hospitals all the food is prepared in the main kitchen and sent down the dumb waiters to the respective floors in covered dishes, and served on trays in the diet kitchens. In others the food is placed on trays in the main kitchen and put on specially prepared carts, which are kept hot by a hot water jacket (in fact, a portable oven), each floor having its own carts, and a porter taking these to the wards, where the trays are then distributed by the nurses. The diet kitchen on each floor in such cases acts as an auxiliary for the preparation of special diets served between meals, and also for keeping local supplies, such as milk, in the refrigerators.

All ranges in kitchens should be built with properly ventilated hoods (as also the gas ranges in the diet kitchens), and the steam tables should be placed under such hoods, having properly constructed vents. The kitchen range in larger hospitals should be placed in the middle of the room, so that it is accessible from all sides—the stack running straight up through the roof and made in

such a manner that the heated stack will act as a means of ventilating the entire kitchen.

THE LAUNDRY.

The fitting up of the laundry in hospitals, depending as it does entirely upon the amount of work to be handled, can cover

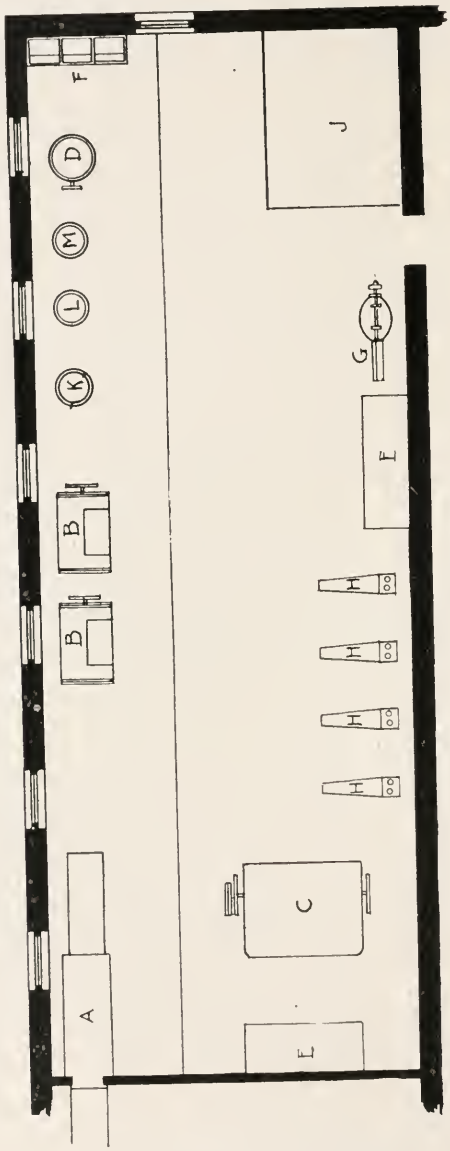


FIG. 268.
Laundry, Showing Equipment.

only in a general way what the room should be and what machines are necessary to do the work with as few hands as possible, the number of such machines depending upon the requirements. Labor is expensive, hence all machines that will eliminate it and facilitate the work of the hospital might rightly be termed necessary.

No part of a hospital needs greater care as to the arrangement and equipment than the laundry, for upon this department depends to a great extent the cleanliness of the institution. In equipping a plant it is always advisable to ascertain the capacity of various machines and their operation.

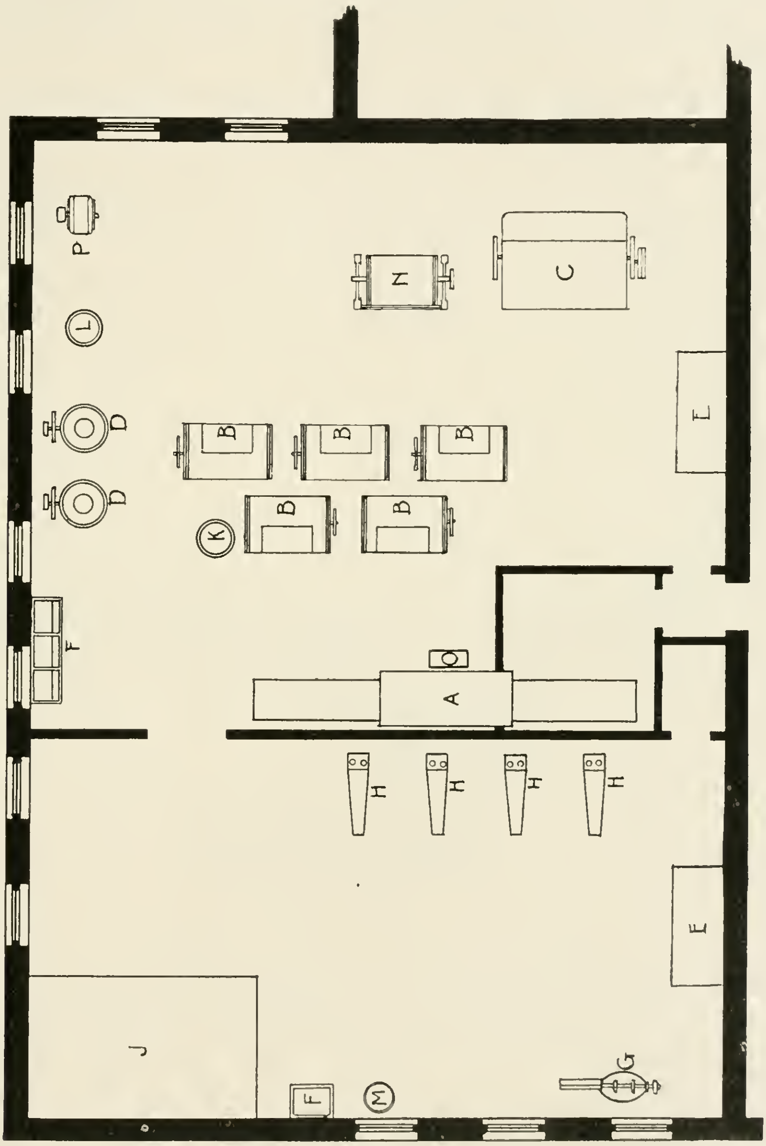


FIG. 269.
Laundry and Ironing Room, Separated.

Room.—The laundry should be in a separate building, if possible, for many reasons, the most important of which is to prevent the odors from passing through the hospital proper. Should a location of this kind not be possible, then the room in which the work is to be done must be provided with as many ventilating shafts as practical. This room should be ventilated by at least

two vent shafts, one being absolutely necessary for modern dryers and the other for the room ventilation. Windows will not always answer for this purpose, owing to the fact that odors going out of windows will rise along the wall and enter other windows above. Light and air are very essential and all that can be obtained should be given, as the laundry at its best is a hot and steamy room. The height of the room should be as near ten feet as possible.

The floor should be of concrete with a cement top, waterproofed as described. A general gutter having one outlet (at least four inches) should be provided. This gutter should be built in and be a part of the floor and placed directly under the

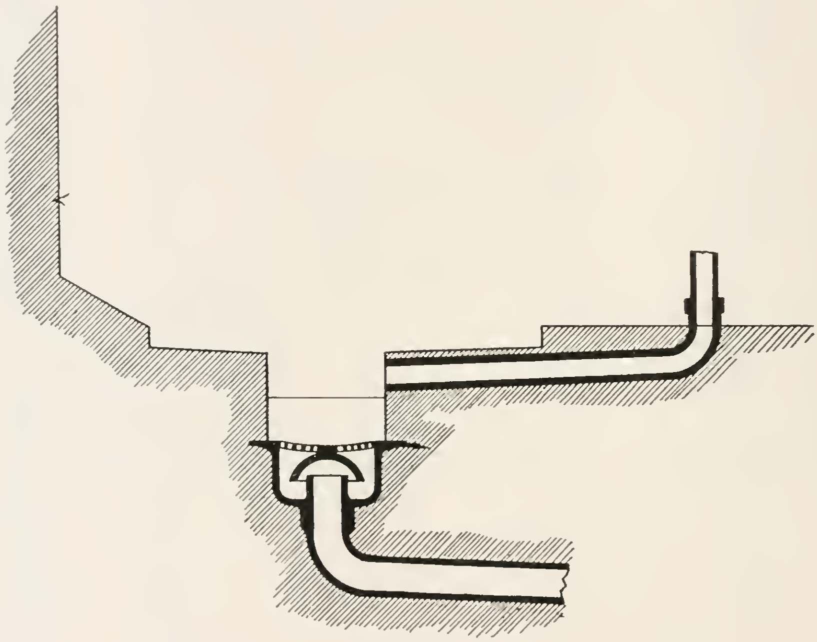


FIG. 270.

washers and tubs with drains running from any place in the room where there is water. These drains should be iron pipes laid in the floor running from the points necessary and placed in the concrete at the time the latter is laid. The sewer outlet should be protected by a screen to prevent lint or other substances from stopping up the pipe. All machines should drain into this gutter and should never be connected directly to the sewer proper, as some article might get into these pipes which could not be readily removed. This applies, however, only to tubs in the laundry. A gutter plan is here shown (Fig. 270).

The depth and width of the gutter should be governed by the amount of water, or the number of machines to be taken care of. The cement floor should have a gradual slope of about one inch

to three feet, so that all of the water will run into the gutter. thus making it possible for the floor to be easily cleaned by flushing with a volume of water. The gutter proper should have a low point at which should be placed a trap sewer connection.

STEAM.—The first essential of an economically operated laundry is the steam supply, and in putting in a boiler for this purpose it is advisable that it have high pressure of not less than forty pounds and not necessarily over one hundred. Should one boiler only be desired for furnishing all steam supply for the institution, it should be so arranged as to be direct connected to the laundry and provided with reducers on all lines not requiring high pressure. Modern laundry machines, such as steam mangles and dryers, require high pressure. The higher the pressure the better will be the results. The boiler room should be as near the laundry as possible, but in every instance in another room or building. A good plan is to have a separate power plant with the laundry above the boiler room. This room should be equipped with steam feed water pump and hot water storage tank for boiler supply.

WATER.—A liberal supply of hot and cold water should be furnished the laundry, and in all cases should run through galvanized iron pipes. These pipes should never be smaller than one inch, and if possible one and one-half to three inches, depending upon the number of machines to be supplied and the amount required for them. The cold water as a general thing is not hard to obtain, but hot water must be supplied. A storage tank for this purpose must be provided. Should the tank for the boiler supply be large enough, then hot water for the laundry can be taken from this or from the house hot water tank, as described in Plumbing.

POWER.—The power to drive the machinery has been described in the chapter on Electric Work. Conditions strongly recommend direct connected electric motors on each machine as stated. With this manner of drive power is used only when the machine is in operation. Besides this advantage it has many good qualities, such as ease of operation, absence of noise and dirt caused by running belts, is not dangerous and is readily put into service. The general opinion is that it would cost more to operate laundry machinery by the individual motor driven than with a steam engine, but this has been disproven in many cases, as with a steam engine the additional cost of coal will generally pay for the cost of electric current. The steam engine, however, is satisfactory, but requires the services of a competent man.

One motor of sufficient size can also be used to operate the

entire equipment, but the disadvantage of this is that the belt and power used to drive the machines must run at all times even under minimum load, as would be the case if part of the machinery was in use and part idle. Gas engines are never advisable, principally on account of the noise, smell and great care needed to keep them in operating condition. If belt power is used, substantial shafting must be provided in good hangers.

In the washing department the best double leather belting should be used, as these belts are subject to great strain when the machines are in operation. They are constantly being shifted from one pulley to another and this department being damp, a poor belt would deteriorate quickly. Should the power be derived from belt drive, great care should also be taken that there be no noise or vibration. These can be overcome by pipe frame shafting construction. Any dangerous belts should be protected by shields.

MACHINERY.

Sterilizer.—There should be placed in the laundry sterilizing and disinfecting machines, through which all goods should

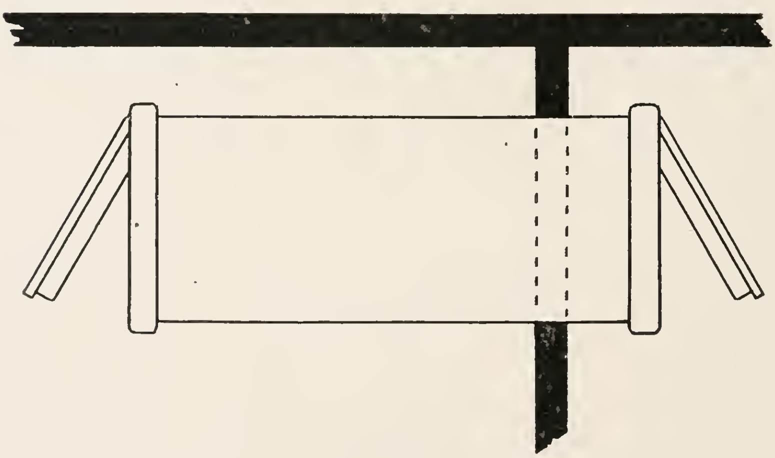


FIG. 271.

pass. These machines are so constructed that they will thoroughly disinfect all classes of hospital goods. They are made with a steam chamber with an inner and outer steel shell, which forms a steam jacket, having cast iron ends and frames in which the doors are fitted with steam pipe copper gaskets. These doors are placed at both ends and the machine should be installed so that one end is in the soiled linen room and the other in the laundry (Fig. 271), making it necessary that all goods must pass through the sterilizer and be disinfected before entering the laundry. The door opening into the laundry room should first be closed, after

which the goods are placed in a wire basket which is run into the machine. The other door is then closed and steam turned into the jacket, which remains filled with steam during the entire operation, thus making the chamber a drying oven. In this manner articles in the machine are brought to a high temperature before the admission of steam to the inner chamber, and are thoroughly dried after the steam has been exhausted. This machine is fitted with an air pump whereby a vacuum of fifteen to twenty inches is produced previous to the admission of steam to the inner chamber (Fig. 272).

Sterilizing Washer.—There are also machines known as sterilizing washers, built entirely of metal having thumb screws to hold the covers tightly. Vent pipes run to an exhaust fan or ventilating shaft from these machines. After the goods are placed

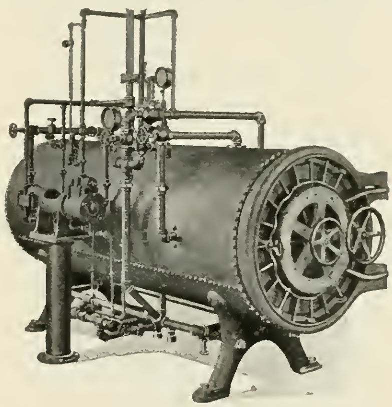


FIG. 272.

in the machine the door is securely fastened and steam turned on, after which the goods are washed in the regular way.

This form of disinfecting is not as thorough as that with a sterilizing machine. The greatest danger in using this machine is the possible contact of germ-laden goods with goods already laundered.

Washers.—Washers for hospital laundries should be made entirely of brass or with brass cylinders and galvanized shells. They should be so constructed for two reasons—first, because they are subjected to severe usage owing to the nature of the work performed, and second, because machines built in this manner are the most sanitary. These machines are made with many combinations, such as those constructed wholly of wood; those of wood with the exception of the iron outer shell heads; those of brass with galvanized iron shells and iron shell heads (Fig. 273), and those built entirely of brass. Those made with iron bearing standards greatly add to the life of the machine.

All machines are of the same general type, but there are some to be obtained which are economical in the use of time and materials required to get the desired results. All washers should be equipped with a steam siphon, as live steam blowing into the linen greatly injures the goods by separating the fibers. The reversing movement which is necessary in washing machines must

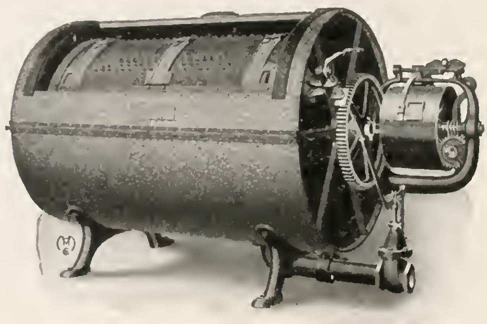


FIG. 273.

be absolutely the same one way as the other to protect the contents of the machine from becoming badly tangled and torn.

Extractor.—This machine is built to extract the water from the goods after being washed and does its work by centrifugal force. The goods are placed in a copper basket which has numerous perforations and which is supported by steel hoops. This

FIG. 274.

basket is built on a steel vertical shaft, at the bottom of which is placed the driving pulley (Fig. 274). Owing to the high speed at which the basket travels this machine is dangerous and it is essential that the best must be procured. One having a cast iron outer casing—cast with the curb-holding balancing rubber springs and provided with a safety rubber bumper so that the basket

absolutely cannot strike the shell should same be unevenly loaded —is the best (Fig. 275).

Soap Tank.—Whether the hospital manufactures its own soap from tallow and soap stock, or purchases a ready-made soap, a soap tank made of galvanized iron is necessary to saponify to a liquid the chip soap that is generally used. This tank should be round and supplied with a circular steam coil placed in the bottom, this to be capped on the end and have small holes about three inches apart so that the steam can penetrate to all parts of the tank. A water supply should be run to this tank and both steam and water connections made so that they can be easily removed, to allow the tank to be cleaned.

Wash Tubs.—As described under Plumbing, stone or porce-

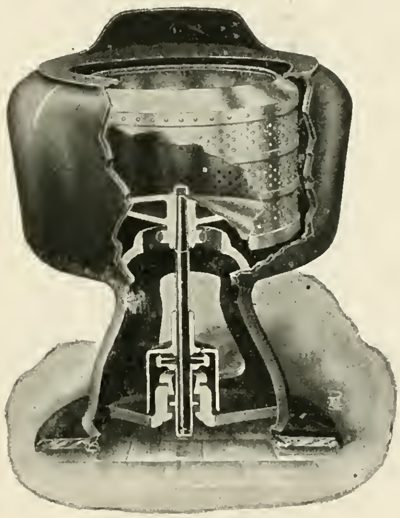


FIG. 275.

lain tubs of not more than three sections should be placed in every laundry, and each section should be furnished with hot and cold water, and one section with a brass boiling pipe (as described for soap tanks) to boil water. This brass steam pipe should be connected with a swinging joint so that the pipe can be lifted up.

Starch Cookers.—Some provision should be made for cooking starch, as there is always need for starch in the smallest institution. This can be done by having a steam pipe arranged so that it can be inserted into a pail. For many reasons, principally the waste of starch, this is not a good process, for all that is made and not used in this manner is generally thrown away. Starch cookers, therefore, should be provided. These are made with an inner lining of copper and an outer casing of galvanized iron between which there is mineral wool and asbestos, which makes

it heat-retaining and keeps the starch hot for a long time. These heaters should be supplied with automatically working covers and condensing traps to separate the condensed water from the steam so that steam only enters the starch. Enough starch can be cooked at a time to last in most cases a week without spoiling (Fig. 276).

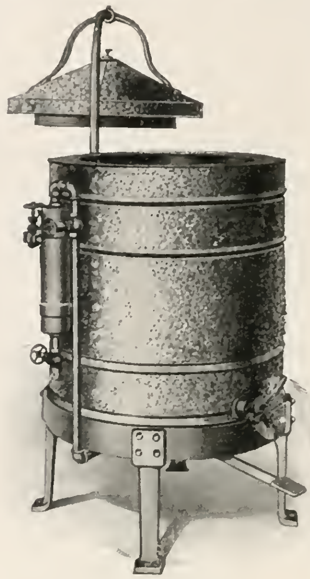


FIG. 276.

STARCHING MACHINES.—The only machines of this kind used in hospitals are those commonly known as dip wheels, which are used for starching collars and cuffs, but this work can be done by hand unless there is a great quantity of it.

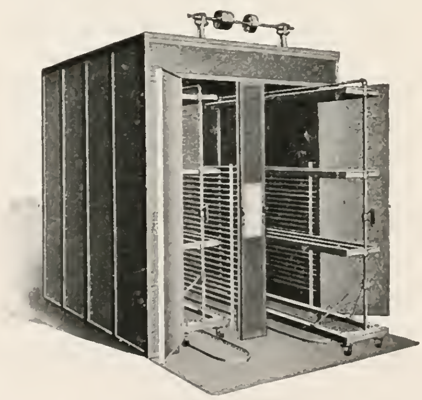


FIG. 277.

DRY ROOMS.—Dryers built in sections and put together, forming a cabinet, are the best for hospital purposes. They are either built of all metal (Fig. 277) or of wood lined with asbestos and block tin (Fig. 278), making them practically fireproof. They are easy to clean and to keep clean. The clothes trucks run on the

floor and can be taken to any part of the room, which allows one to enter the dryers as they would a large refrigerator. The heat is derived from three steam coils, standing vertically in the room, one at each side and one in the center almost completely surrounding the trucks on which the clothes to be dried are hung. These rooms hold two trucks at a time and as three are furnished, allows one to be unloaded and reloaded while the others are drying. Other commendable features of these dryers are the circulating fan in the top, which drives the heat to the bottom and forces the moisture out through the ventilating pipe (which must be supplied) greatly facilitating the speed of the drying. Under ordinary conditions with eight pounds pressure of steam these dryers will perform their work in thirty minutes. The space taken up is very small in comparison with the draw dryers of similar capacity.

A good steam trap should be installed with the dryer, allow-

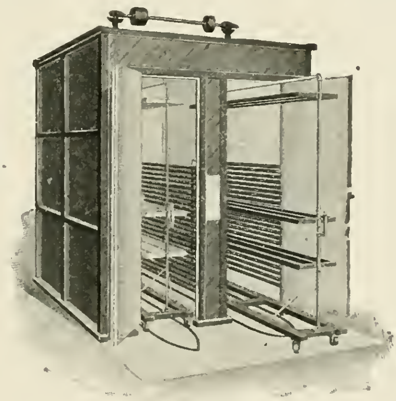


FIG. 278.

ing all the water to escape and holding back the dry steam, thus keeping the pipes clear of water and as hot as the steam will make them. It would be well to return this condensed water to a tank to be used for the washing of flannels and delicate fabrics.

MANGLES.—The mangle is one of the most important machines in laundry equipment. In all modern laundries flat work is never dried, as it is taken direct from the extractor and fed through the mangle. High steam pressure is absolutely necessary to obtain results from these machines. A machine with a heated cylinder, the size to be governed by the amount of work to be done, is the best. They are made with cylinders 16, 24 and 48 inches in diameter, by 48, 64, 75, 90, 100 and 120 inches in length, around which at various angles are placed auxiliary rolls, which rolls are covered with wool covering and between which pass the goods being dried and ironed (Fig. 279). A cylinder machine having a lower apron attachment by which the goods pass completely

around the cylinder, being deposited upon a table directly under the feed into the machine (Fig. 280), and which allows the work to be handled by two operators, is by far the most desirable for an institution handling about three thousand pieces per day. If the

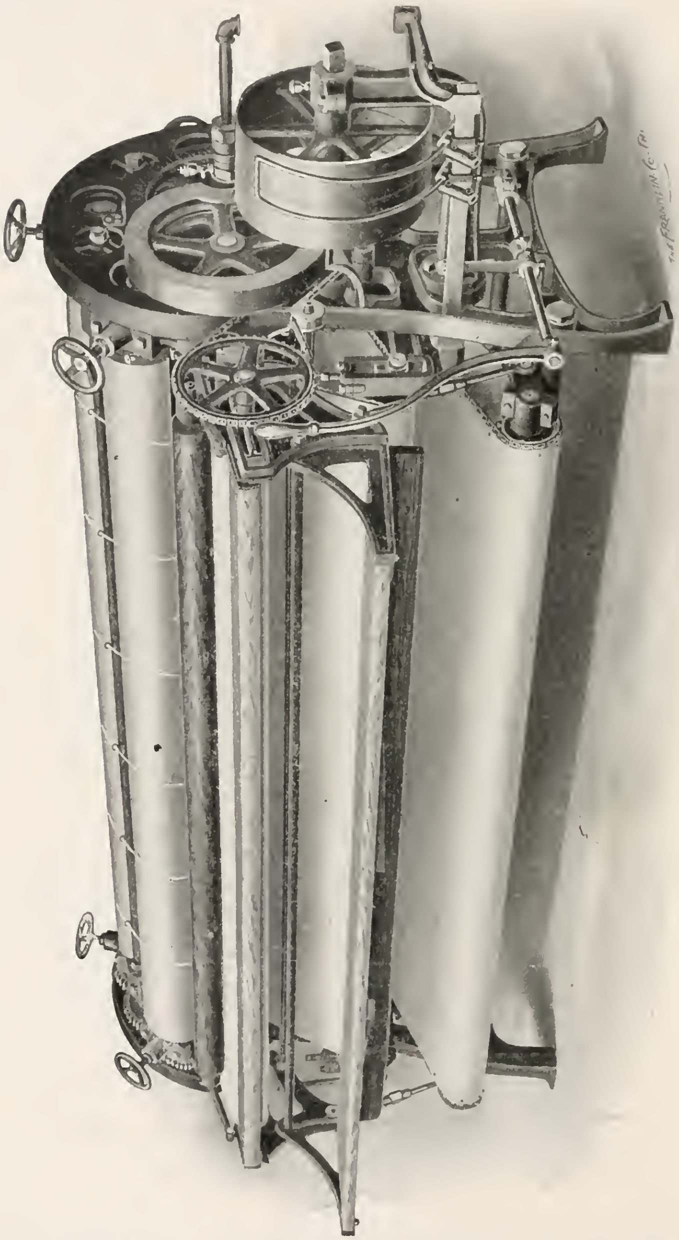


FIG. 279.

institution has more than the above number of pieces to launder, it would be necessary to have a machine having a second lower apron attachment, which would carry the goods to the opposite side from which they are fed (Fig. 281), after they have made a complete circuit of the cylinder, which allows the feeders to do

nothing else and requires folders where the goods come out. Cylinder machines are preferable to other forms, because they are much easier on the linen, cheaper to maintain and the space required is smaller for their installation. They are easier on the linen, especially the hems, because the cylinder, auxiliary rolls and the goods travel together; cheaper to maintain, because the wool covered rolls come in contact with the heated surfaces at a point of contact of less than one inch, and that the steam rising from the damp goods escapes instead of penetrating the blankets, which soon rots them. No mangle should be considered unless it has an automatic apron feed, as shown in the illustrations, for without it it is impossible to feed the goods straight and without

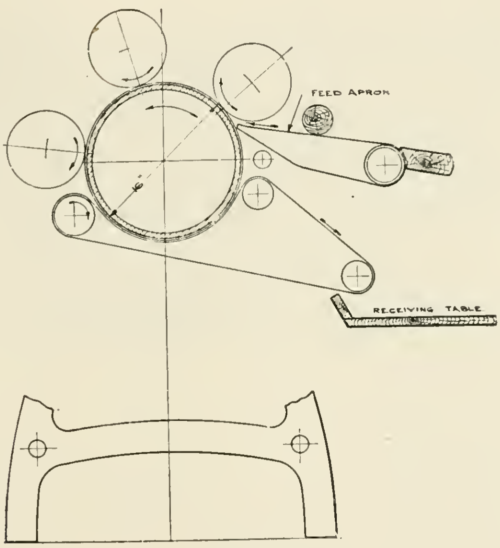


FIG. 280.

turned edges, but more important than this, it absolutely prevents the operators from being caught in the machine while feeding. A steam trap should also be connected with this machine, for the same reason as referred to in regard to dry rooms.

Body Ironer.—The body ironer (Fig. 282) derives its name from the fact that it was first used by launderers for ironing shirt bodies, but now used to iron underwear, aprons, coats, skirts, stockings, handkerchiefs and almost any other garment that must be ironed. The principle of the machine is the same as that of the mangle. Two rolls, one hot, the other padded, are pressed together and revolved at the will of the operator, and between which the articles being ironed are placed. This machine with one operator can easily do the work of four hand ironers, and in many small institutions takes the place of the mangle. The roll is heated by electricity or gas.

Ironing Boards.—In every laundry there should be at least two ironing boards, built on iron bases equipped with sleeve boards. If gas heated irons are to be used, these boards should be fitted with sad iron heaters.

Irons.—The use of electrically heated flat irons is recommended, as they are both economical and clean. If the ordinary irons are used, gas sad iron heaters made especially for heating flat irons should be provided.

Accessories.—Bleach and bluing jars are necessities in all well-equipped laundries, as are also scales, graduated glasses and measures. All work in the washing and starching departments should be exact.

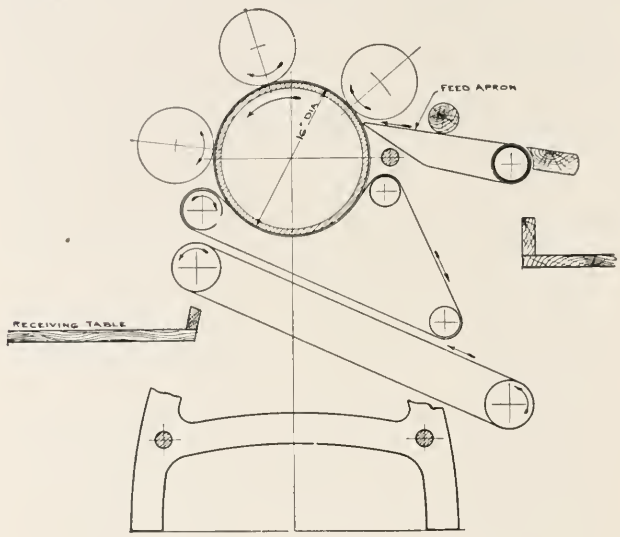


FIG. 281.

All steam pipes should be well covered with asbestos pipe covers.

If the institution is a large one in which it is necessary to launder on an average of five thousand pieces, or over, a day, a machine known as a Tumbler should be installed. Its work is to take the goods as they come from the extractor, where they are packed in a solid mass, and shake them up to remove all lint, etc., making a great saving in the labor required to shake the goods out before they can be fed into the mangle.

Should there be a considerable number of collars and cuffs, say more than can be ironed in an hour by hand, a small ironer for this purpose should be provided. These machines are made with a heated and a padded roll, between which the collars pass in such a manner that a much greater pressure is obtained than is possible on a body ironer or by hand.

The laundry should be supplied with a curtain stretcher.

Frames of many kinds are made for this purpose, but the best of these are made of galvanized iron pipe having adjustable corner sockets, or in the form of curtain trucks, which can be run into the regular dry rooms.

Blanket Drying Closets.—In all modern hospitals there should be provided on each floor upon which there are patients, a space or room in which blankets can be quickly and readily dried. Such space need only be large enough to admit a drying rack on which the blankets can be hung. It is not convenient nor expedient to carry all blankets, which have become damp or wet in the treatment of typhoid cases, or from other causes, to the basement or roof.

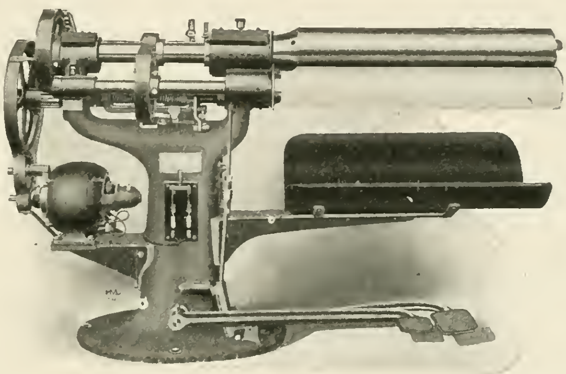


FIG. 282.

The simplest form of such a drying rack could be made by placing wooden poles horizontally in a closet off the bathroom over which the blankets can be hung, and into which closet are introduced steam coils or some form of heating. A sliding rack could also be run on tracks into a narrow room, or in part of a room, for this purpose. A small drying room such as is provided for laundries would be admirable in the latter case, as this could be heated by steam or gas.

A space could be provided also for this purpose by building a slot about three feet wide, and a sliding rack either on tracks or on overhead track, and when the blankets were on the racks or when the drier was not in use could present on the exposed side a panel which would be flush with the wall of the room in which the rack was placed. All spaces for drying blankets must be thoroughly ventilated, and should under all circumstances be accessible for cleaning purposes.

CHAPTER XXV.

HOSPITALS FOR TOWNS OF ABOUT 5,000 INHABITANTS.

Every town containing five thousand or more inhabitants must eventually organize and conduct a hospital. In these towns there will be a sufficient number of persons who have elsewhere experienced the benefits of hospital care to demand the same facilitis for themselves and their friends at home.

Formerly only the gravest cases were sent away to hospitals for treatment, and the too frequent unfavorable results from the treatment of these hopeless cases did not serve to make such institutions popular. During the past seventy years all of this has been changed, and there are now thousands to sing the praises of these institutions, and the incentive for building them lies in the fact that they will be an advantage to the community, and more especially an advantage to the physicians who will be active in their organization and maintenance.

To build one of these institutions represents one of the opportunities of the present century. There is always an opportunity in hospitals, as well as industries, during their rapid development, and those who are active in these enterprises may utilize all existing precedents to great advantage in their work without being hampered by precedents in their development. The effect of this truth is well shown in comparing the organization and conduct of many of the hospitals in the newer with those in the older cities. In the former the spirit of progress is found, while in the latter progress is often greatly curtailed by custom and routine, which must necessarily endanger the success of these institutions. This objection is very apt to come from lack of judgment in persons at the head of the institution, but this fact must be accepted in the development of all industries. There must be lack of judgment, lack of experience, lack of qualifications to guard against, in order to secure the success of any competitive undertaking.

So far experience has established what is best regarding location of a hospital, position of the buildings, arrangement of the finances, organization of nursing staff and servants, etc. In a few instances satisfactory buildings have been constructed from the standpoint of convenience, economy and safety.

Regarding the organization of the medical staff, there is as yet no satisfactory precedent for hospitals in towns whose population is not sufficient to support more than one of these institutions.

LOCATION.—The greater number of hospitals in cities of not over five thousand, or less than three thousand, inhabitants, have been located somewhere near the center of the city, the same principle being applied in the choice of a location for a hospital as would be used for a mercantile house or a postoffice, with the idea that accessibility would result in patronage. In many instances the physicians interested have determined the location to suit their own personal convenience—near the center of the city, within walking distance from their offices or their homes; and then it often happens that within a few years the location is found most unsatisfactory, with the result of abandoning the site and establishing a new hospital in a suitable location, or more frequently a competing hospital organization builds a second hospital in a better location.

The various sisterhoods have shown better judgment in the choice of location because of their natural heed to precedent.

The best location for one of these village hospitals would be a mile from the edge of the town, not nearer than one-half mile from a railroad track, nor one-eighth of a mile from a street car track. It should be near a good highway for the convenience of carriages and ambulances. The hospital grounds should contain at least five acres, and as much more as can be secured. A few hospitals in this country are superbly located on grounds which previously served as private parks, and were donated for the purpose by their former owners. In many of the older villages it is possible to purchase such grounds at a reasonable price, or it is possible to procure a small farm for the purpose. These rather distant locations have always proved very satisfactory. Besides providing a proper permanent home for the institution, it tends to eliminate from the institution many meddlesome members of the medical profession who would find it inconvenient to travel a mile in order to visit an institution in which they had only a negative interest. On the other hand, the competent, industrious members of the profession will go to the hospital with regularity and will not object to the extra time spent in reaching it.

The higher the grounds the better, because of the advantage this gives in securing good ventilation and drainage.

POSITION OF BUILDINGS.—The best arrangement as regards position for these buildings can be obtained by planning a long, narrow building with a central hall running north and south. This

insures either morning or afternoon sun for every room in the hospital and midday sun for the central hall.

Size of Hospital.—The size of the hospital should depend upon the size of the town, the prospects for rapid growth, the population of the country tributary, and more especially on the skill of the members of the profession who are in charge of the institution. In a general way it may be said that it is not wise to plan a hospital with less than sixty beds for a town of six thousand inhabitants or over. Rather than construct a hospital that would be found too small within five years' time, it would be better to occupy temporary quarters for a few years, and during this time secure permanent grounds and plan the permanent structure.

There are three methods which may be followed in order to secure a hospital sufficient in size to satisfy the future conditions. These methods may be employed individually in any given institution, or they may all be combined.

First—The hospital may be so arranged that ultimately the entire building can be utilized for housing patients. In the meantime, while the patronage of the institution is still insufficient to require the entire building, the top floor may be used for operating rooms, kitchen, and dining rooms. The remaining rooms on the floor may be occupied by the nurses as a temporary home.

After assigning the necessary rooms for office and waiting room, the first floor may be used temporarily by the matron, the servants and the resident physicians. In case this does not supply a sufficient amount of space, the first and second floors may be utilized for this purpose and the remaining floors serve as wards and rooms for the patients. When the patients become so numerous that more space is needed, the nurses may be moved to rented quarters and later on the servants may be moved. When the requirements demand it, a separate building for the offices and home for nurses and servants may be built. It would not be necessary to make this building fireproof in localities where such construction would be much more expensive. With the aid of stand pipes and properly constructed fire escapes such a home and administration building would be perfectly safe, as it would be occupied entirely by able-bodied adults.

The second method of enlargement would be to add to the first plan one or more blank stories, containing only the outer walls, the windows and the inside fire walls—no partitions, plumbing, floors, doors or heating apparatus. With this arrangement it would be possible to add at any time from fifty to a hundred per cent. to the capacity of the institution at a small additional cost.

The third method would be the building of a structure ulti-

mately to be used for nurses and servants, which could at first be used for patients, and then in due time construct an entirely separate building for them.

A fourth plan has been tried, both as an independent scheme or in connection with one or more of the above methods. This consists in putting up a central building originally and then to increase in the form of additional pavilions. Eventually this plan will undoubtedly be adopted, though up to the present time the results have not been satisfactory, owing to the inconvenience of the arrangement, and the unsightly exteriors. With the improvement in hospital construction these unsatisfactory elements will gradually be eliminated, as the original plans will be likely to contain the conditions necessary to satisfy the future requirements.

ORGANIZATION.—The principles underlying the organization of these hospitals are the same as those which obtain in the organization of hospitals in large cities. Hospitals in smaller towns have, however, this great advantage, that they can secure men to act as trustees who have the respect of the entire community. This one fact alone adds strength to an institution. The number of trustees selected should be not less than five, nor more than fifteen. The board of Trustees should be self-perpetuating and the duties should be those described in the chapter pertaining to this matter.

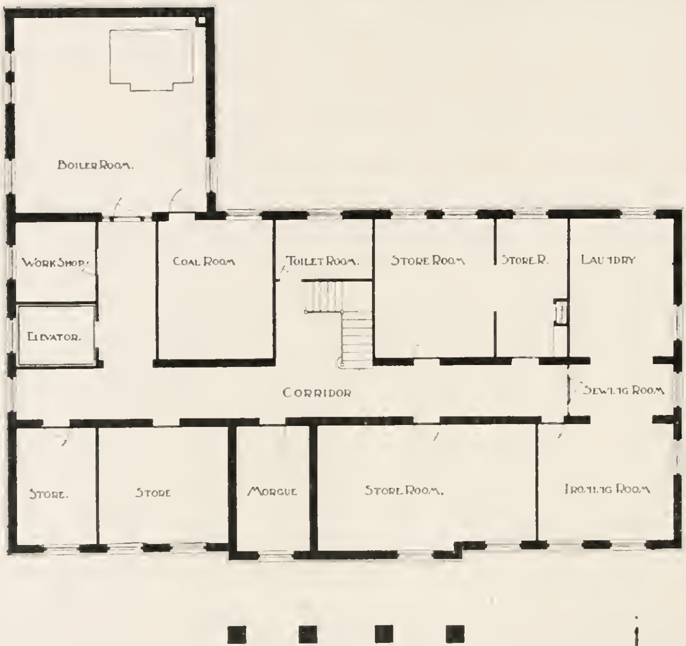
FINANCES.—As indicated in the section on this subject, the finances of these institutions must be managed in an absolutely business-like way. One element must be carefully observed in order to make the continued usefulness of these institutions possible. The maintenance of every individual patient must be paid for by some one. This may be done by the patient himself, by a friend, by some church or society, or by the use of some established fund; but it must be paid.

Another principle which must be adhered to is that the total expenditures for the year are kept within the income, except in case of great emergency. If these two important principles are closely followed, and if the care of patients is in the hands of competent, conscientious physicians and surgeons, these institutions will be certain to prosper, while without these it will be equally certain to fail, even though great sums of money are expended in its maintenance.

NURSING STAFF.—No part of these institutions should be better organized than the nursing staffs. In the smaller ones the superintendent of nurses may occupy the position of superintendent of nurses, matron and surgical nurse. In the larger institutions a housekeeper or matron may be added, and if the hospital contains

more than one hundred beds there should be an assistant superintendent who may at the same time serve in the capacity of head nurse in the surgical department.

BUILDINGS.—The buildings should be attractive, simple and safe. If more than three stories in height they must be absolutely fireproof. If three stories or less in height they should be fireproof when possible. When this is not possible because of local reasons, every precaution should be taken to make the building safe. The broad halls should open at each end of the building through large doors upon broad verandas. The stairs should be wide and easy. There should be stand pipes with attached hose;

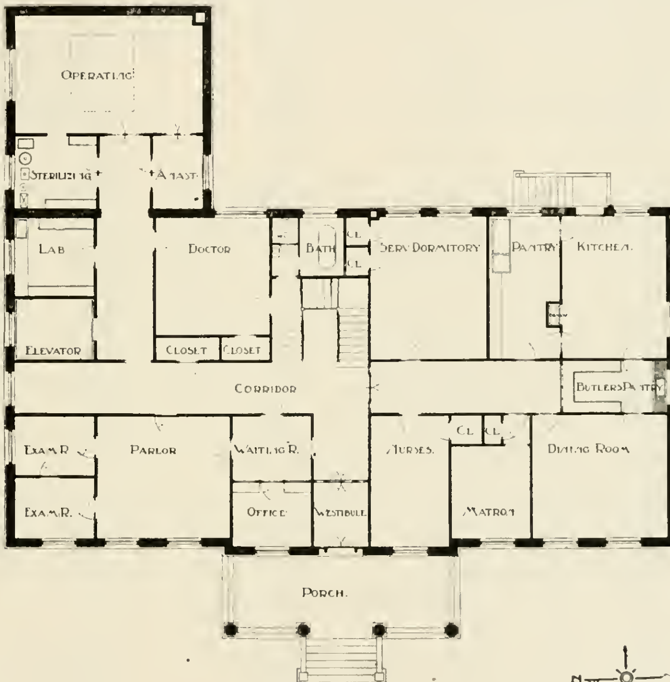


Basement Plan
A Country Hospital
Meyer J. Sturm, Architect.
FIG. 283.

the walls and floors should be constructed as nearly fireproof as conditions permit. This is not intended as a justification for building hospitals which are fire traps, but to suit conditions where it is preferable to have a non-fireproof hospital rather than no hospital at all.

Figures 283, 284, 285 represent a small country hospital intended to serve later as a home for nurses. At each of the short ends a large porch is to be built, although it is not shown in the figures. It may be built two or three stories in height. In case it is two stories in height the veranda is to form a balcony on the second story. In case of three stories there is to be a porch on the second story and a balcony on the third. With two stories it

will house from eleven to fifteen patients, with three stories, twenty-two to thirty. Two of the rooms are connected by a private bath and toilet room. When changed into a home for nurses and servants it will house fifty-eight people if three stories in height, or thirty-seven if two stories. Each of the rooms on the second and third floors, with the exception of the two located in the northeast corner, are large enough to serve as sleeping room for two nurses or servants. On the first floor the kitchen, pantry and dining rooms are to be transformed into dormitories, as these departments are to be placed in the first story of the hospital



First Floor Plan
A Country Hospital

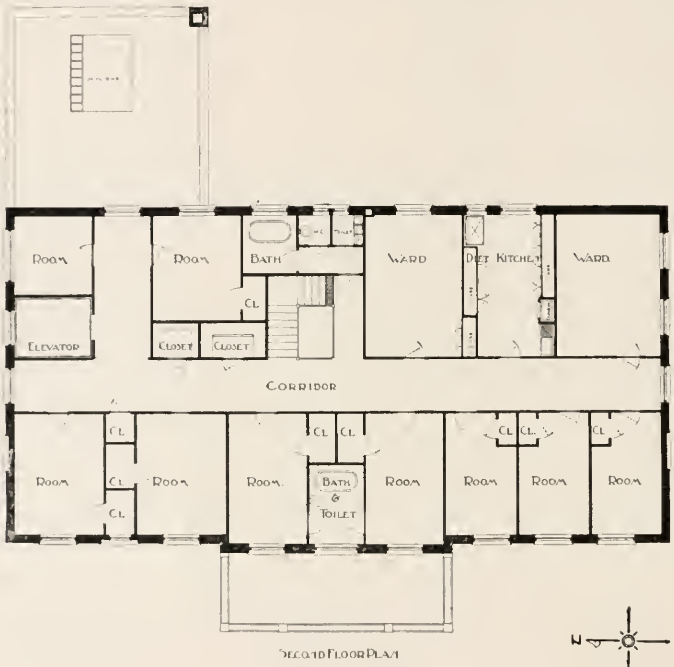
Meyer J. Sturm, Architect.

FIG. 284.

building proper when the original building has become too small to house the patients. The operating room may be changed into a library or a recreation room for nurses. The sterilizing and anesthetizing rooms may be utilized for any purpose that conditions may indicate. This plan will serve as a general example.

The hospital plan as designated in Figures 286, 287, 288, 289 may be increased in size indefinitely by lengthening the building or by adding any number of stories. A few changes—which will be indicated later—will be necessary if this building is to be enlarged to accommodate two hundred or more patients. If the original building will house between fifty and sixty nurses and

servants, the new building should be planned for about one hundred patients, and in addition one or two unfinished floors should be provided to fill possible future requirements. In this case it would be best to arrange the first floor of the new building to be used for offices, waiting rooms, examining rooms, laboratory, house physician's rooms, library, parlor, office of superintendent of nurses, nurses' class-room, and, if the conditions require, a chapel that should also be placed on this floor. This latter provision is a very important one, because it will enable the friends of the hospital to attend chapel without interfering with the comfort of the patients, all of whom will be above the first floor.



Second Floor Plan
A Country Hospital
Meyer J. Sturm, Architect.
FIG. 285.

Another change that would be indicated in case the hospital were eventually to provide for more than one hundred patients would be a separate building for boiler-room, coal-room, power plant and laundry. This auxiliary building can be arranged to contain a small department for contagious diseases which might develop in the hospital, or which might be admitted under a mistaken diagnosis. If such a department is added, it should consist of two small wards, a nurses' room, a bathroom and a toilet room. By placing the doors properly these three departments can easily be arranged so that they will in no way interfere with each other. This building should also contain the morgue.

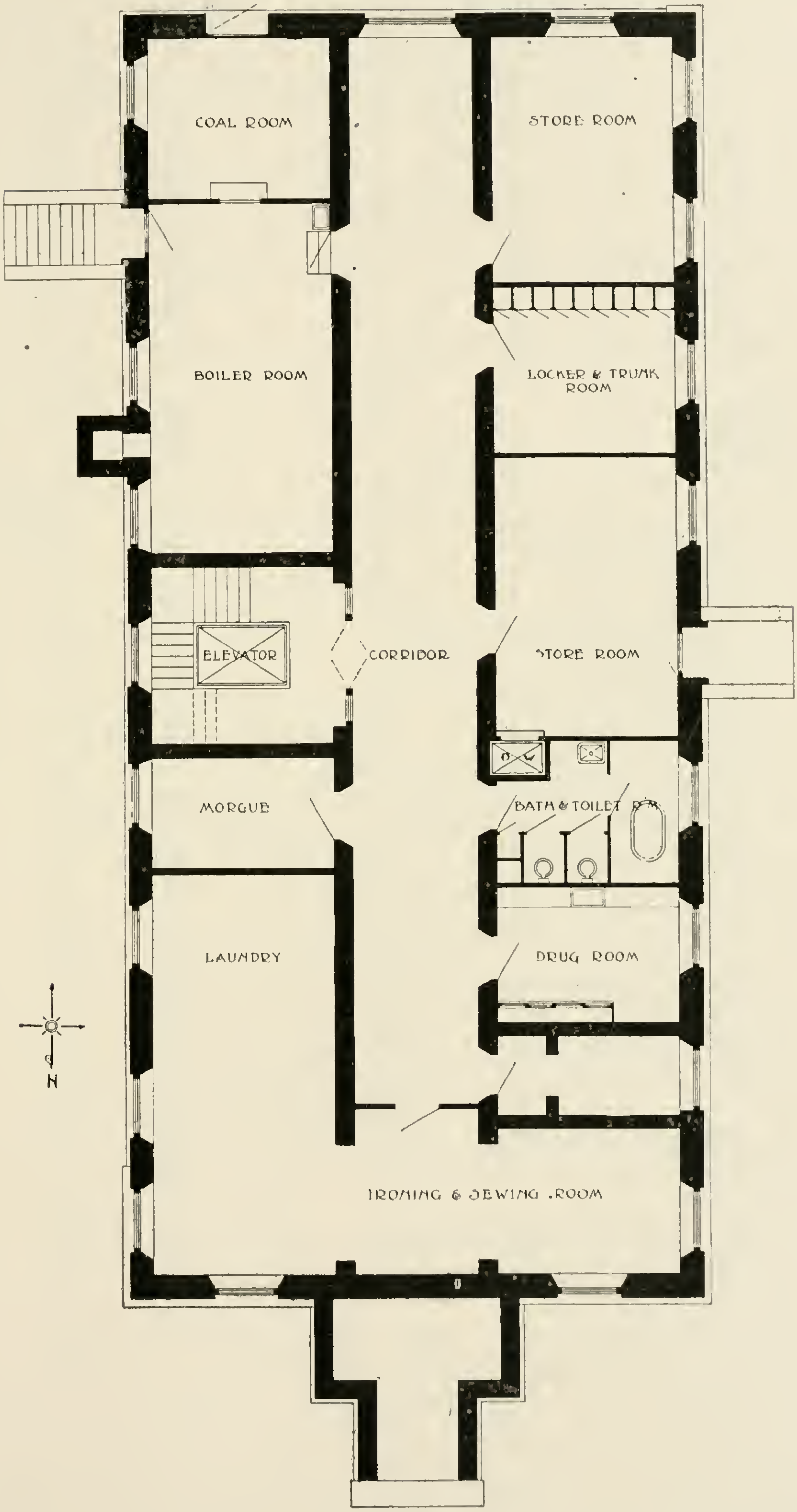


FIG. 286.

Basement Plan. Lucy Brinkley Hospital, Memphis, Tenn. Meyer J. Sturm, Architect.

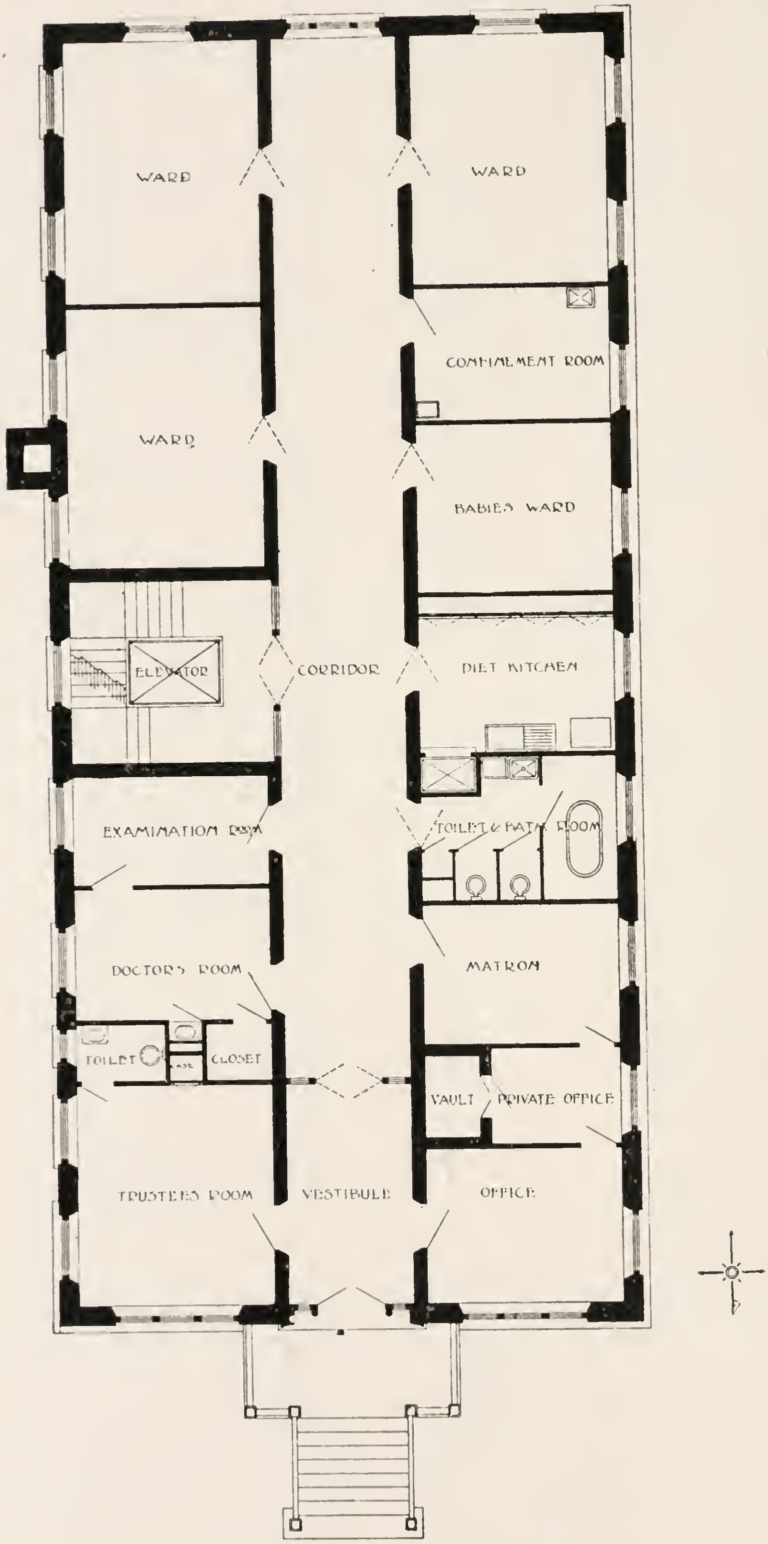


FIG. 287.

First Floor Plan. Lucy Brinkley Hospital, Memphis, Tenn. Meyer J. Sturm, Architect.

This arrangement will allow for the housing in the nurses' home, Figure 283, 284, 285, a sufficient number of additional nurses

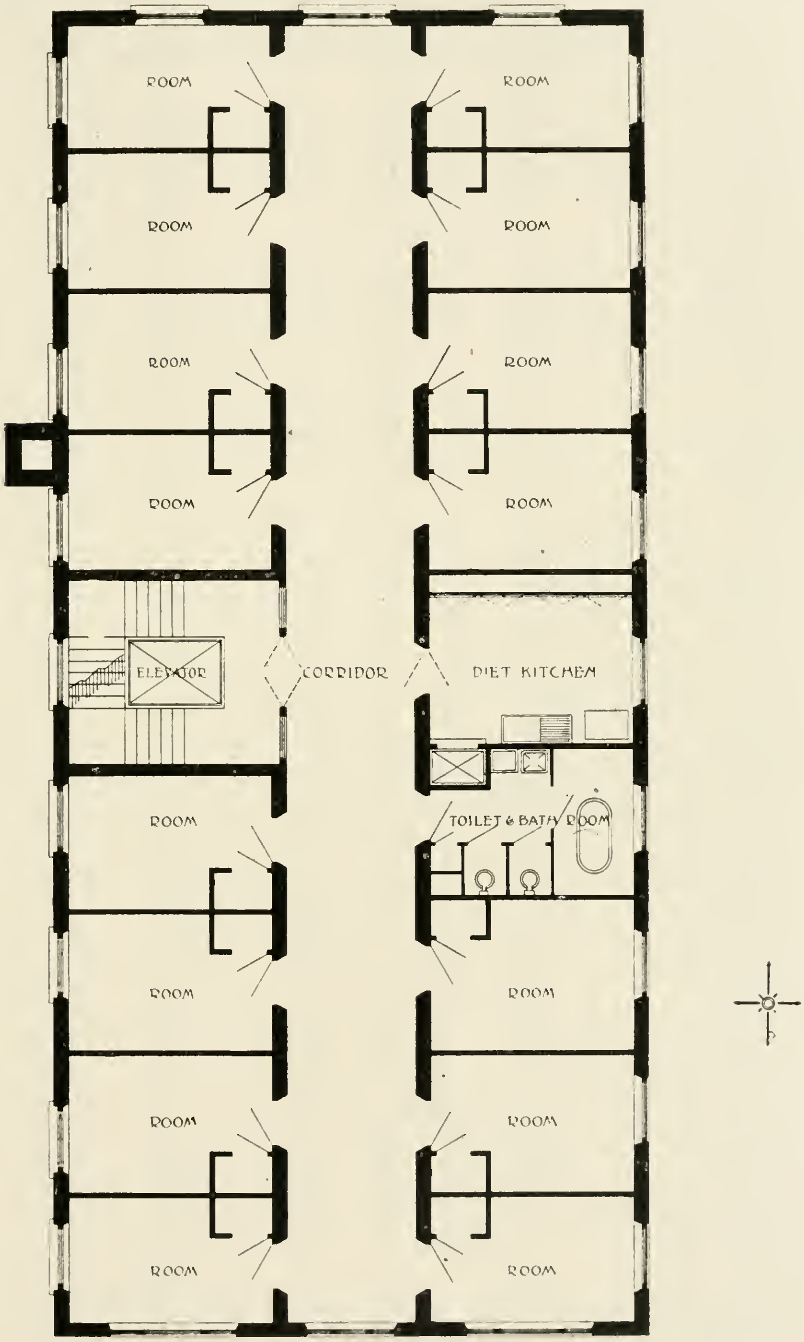


FIG. 288.
Second Floor Plan. Lucy Brinkley Hospital, Memphis, Tenn.
Meyer J. Sturm, Architect.

and servants to supply the increased demand. If the institution is located in a community which will eventually demand hospital ac-

commodations for two hundred or more patients, then the original Figure 283, 284, 285 should be planned larger to suit the condi-

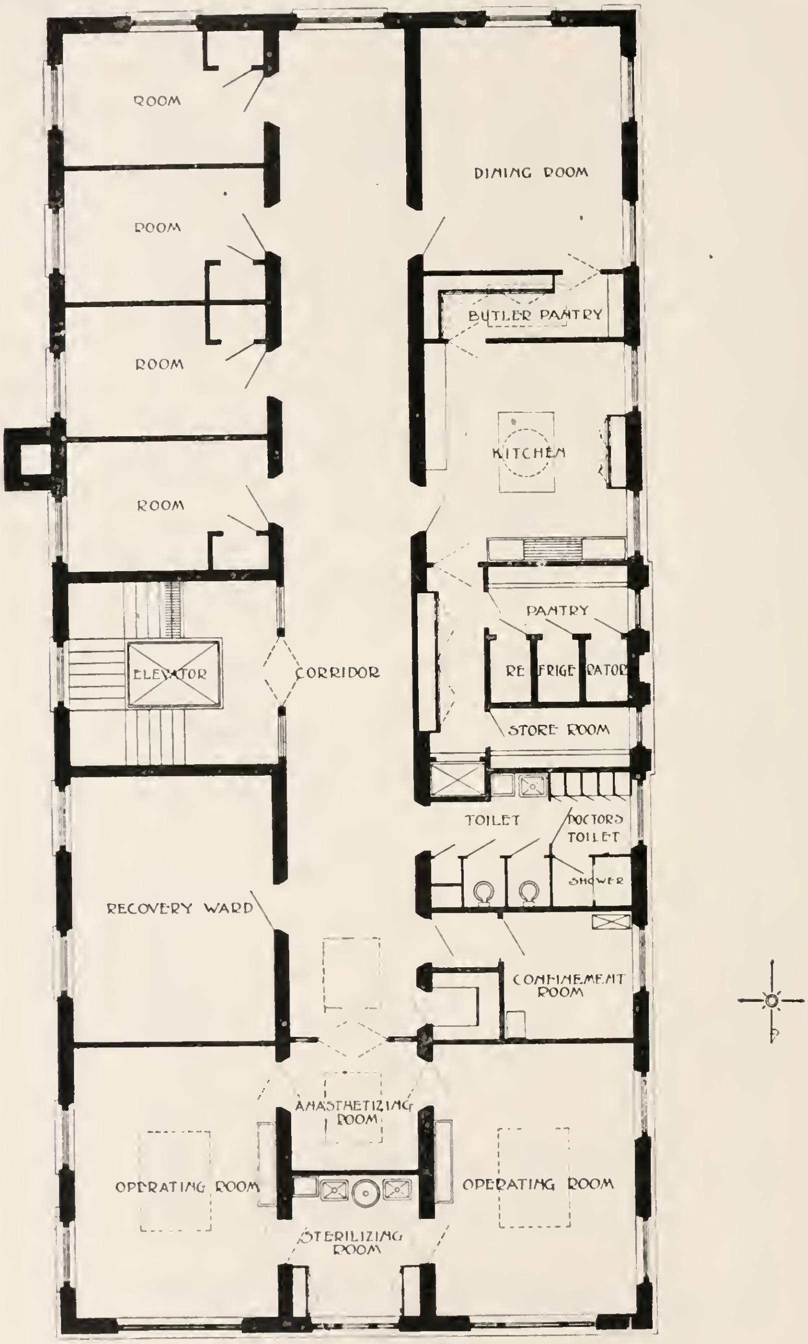


FIG. 289.

Top Floor Plan. Lucy Brinkley Hospital, Memphis, Tenn. Meyer J. Sturm, Architect.

tions. This can be done very readily by adding to the length of the building.

In the plans under discussion all of these conveniences have been provided for with the exception of the department for contagious diseases. The building may be entirely occupied by adult female patients, gynecological and obstetrical, hence it is relatively easy to provide against the admission to the hospital of any suffering from a contagious disease. In case an accident of this kind should occur the patient should at once be removed to comfortable quarters outside the hospital, and supplied with a private nurse to give her the best possible care.

In considering these plans, 286, 287, 288, 289, it should be stated in the beginning that this hospital represents an institution belonging to a class which must predominate in all the towns and cities of this country, with the exception possibly of a dozen of the larger cities where conditions exist which force them in a separate class. This hospital represents a type in which a part, or all, of the money for the purchase of the grounds and the construction of the building has been given to the trustees by philanthropic persons, but in which the money for the maintenance of the institution must be provided by the patients treated, by their friends, or some church or fraternal society. It is consequently important that the institution be planned so as to provide the best possible care at a cost not to exceed an amount which could be reasonably obtained from the sources mentioned.

Beginning with the basement, we have a number of departments conveniently arranged at a minimum expense.

In this institution the power for running the elevator and laundry machinery is secured from a neighboring electric plant. This plan is desirable in many cities where one can buy electricity cheaper than it can be made on the premises. Were it necessary to manufacture electricity for lighting and power, a portion of the boiler-room, near the elevator, could be partitioned off for this purpose.

The laundry, ironing and sewing rooms are located at the extreme end of this floor, entirely separated from the boiler and engine rooms. These rooms are especially well lighted and ventilated. If desired a second swinging glass door may be placed just to the north of the elevator in order to further interrupt any slight noise from the laundry.

The general store rooms, locker, trunk room, drug room, bath and toilet rooms provided by this plan are so evidently convenient that it will not be necessary to discuss them especially. The store room at the south end may be utilized for a general workshop for repairing furniture, painting bedsteads, making splints, and many other things that are constantly to be done in an institution.

Figure 287 represents the first floor in which one-half of the total floor space is utilized for administration purposes, the remaining portion for housing obstetrical patients and infants. Were the administration departments housed in the auxiliary building described in Figures 283 to 285, the space for patients would be greatly increased. Under the present condition the room labeled "Trustees" may be used as a general sitting room or parlor and library, except during the few hours each week when the trustees meet. The hospital portion proper is separated from the offices by swinging doors, so that the patients are not disturbed by people whose business takes them to the hospital office. It will be noticed that the elevator is entirely separated from the hall by swinging doors. Too much stress cannot be laid upon the importance of placing swinging doors at every point at which a door is actually intended to separate departments.

The bath rooms on all the floors correspond in location so that but one stack of plumbing is required. The diet kitchen is directly below the general kitchen, and also corresponds in location to those on the succeeding floors. The diet kitchens are connected with the general kitchen by means of a dumb waiter, and in a six-story building food would have to be carried less than a distance of sixty feet before delivering it on the lowest floors for distribution.

Figure 288 represents one of the intermediate floors. It corresponds exactly with the first floor so far as the location of the elevator, the diet kitchen, bath, toilet and service rooms are concerned. It will be seen that the floor provides an enormous proportion of space for occupation by the patients, compared to the amount given to service rooms. Counting the space occupied by the elevator, not much more than one-fifth of the floor space is given to administration, which is less than one-third of the space allowed for these purposes in many institutions. This serves not only to lessen the cost of construction, but to greatly reduce the running expenses of the institution. If it is desired to have wards on one or more of the floors, instead of having only private rooms, they can be obtained by leaving out the first and third partition on each side of the elevator and the corresponding partitions on the west side of the building. The fifteen private rooms will then be changed into seven four-bed wards, and one separate room, which may be used for one or two beds. It would be well to have a movable steel wire window screen in this room, in case it should be necessary for a delirious patient.

It is plain that the capacity of the hospital may be increased by additional stories, or it may be increased by lengthening at

either end. As has been mentioned before, it will be necessary to provide for an additional elevator if the total capacity of the building exceeds 150 or 200 patients.

Figure 289 represents the top floor, with the operating department at the north end. The operating room is provided with very large plate glass windows facing north, and with large skylights facing in the same direction. The drawing shows east and west windows which are placed in position to prevent the unsightly appearance of the outside wall. In order to prevent troublesome shadows and the annoyance of sunlight upon the operation field, steel sliding curtains should be placed so they can be closed before the preparation of the room is begun on operating days. After the operations have been completed these windows will serve to air and sun the room.

The recovery room in this plan is one large room, as only female patients are treated in this hospital. Just south of the elevator on this floor, a partition with swinging doors should be placed, which will serve to separate the operating department from the kitchen department. There will be an abundance of light in the north end from suitable skylights placed at this point. The swinging doors have not been shown on this drawing.

A second provision for the separation of these two departments is in the form of double swinging doors at the entrance of the anesthetizing room. This room and the sterilizing room have been placed so that they may be utilized with equal facility in connection with both operating rooms.

The confinement room is on this floor and is provided for patients occupying private rooms. The toilet room on the floor contains a shower bath for the surgeons, a series of individual lockers, closets, slop hopper and sink. In a larger hospital two rooms may be provided with these conveniences.

As stated before, this plan represents a most satisfactory hospital for the conditions for which it is designed. It is built entirely of stone, brick and reinforced concrete and is absolutely fireproof. Its cost is somewhat less than one thousand dollars for each patient it will accommodate.

HOSPITALS IN SMALL TOWNS.

In connection with the construction of very small hospitals in towns which are not large enough to support an institution of considerable size there are many things to be considered by the community, as well as by the practitioners who undertake to establish such an institution. In the first place, with the introduction of these small hospitals there follows the same distinct gain

in the care to be obtained for cases which in larger cities would go to hospitals. Such patients are compelled in the smaller towns to be satisfied with very unsatisfactory home treatment, unless they can assume the expense and inconvenience of transportation

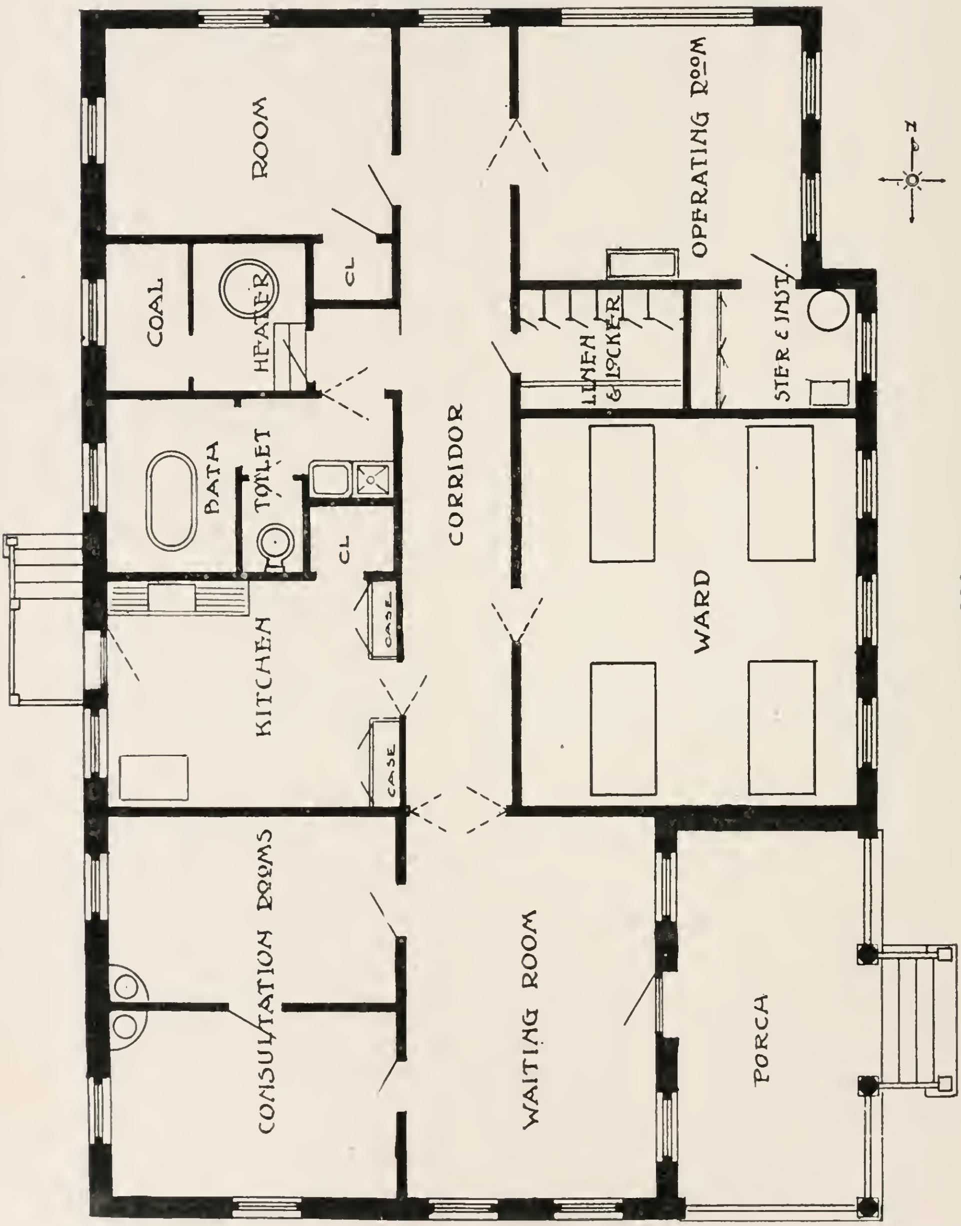
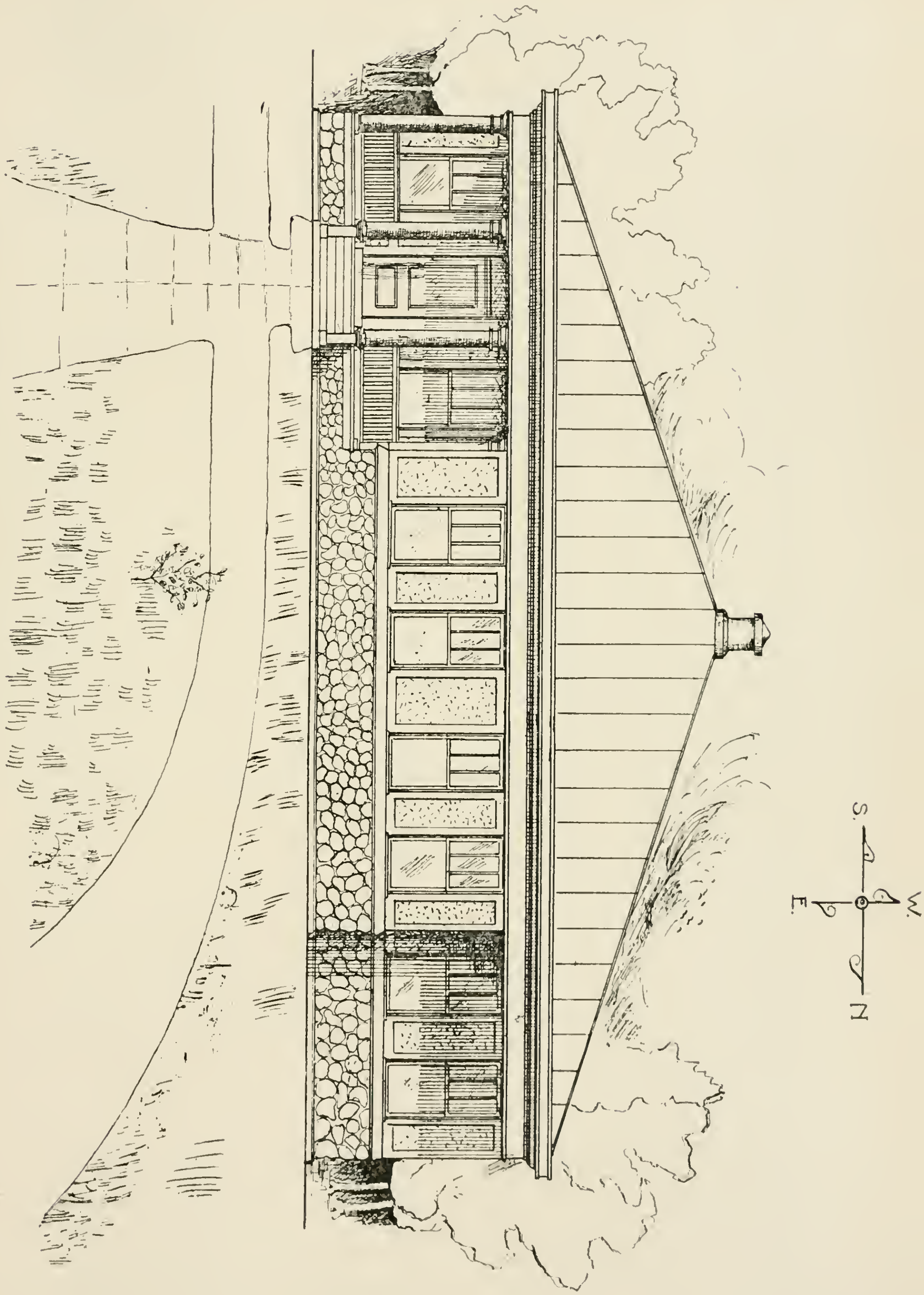


FIG. 290.
Meyer J. Sturm, Architect.

to a city hospital. For example, a patient might sustain a severe fracture at some distance from home. A temporary dressing could be applied by almost any one at hand; the patient placed upon an improvised stretcher, say a cot bed or wire mattress, and on



ELEVATION

FIG. 291.

this transported to the village hospital in a comfortable wagon to be found on any farm. In the hospital the patient would be under daily observation of the physician until his condition warranted removal to his home. All this with vastly less labor on the part of the physician, and much better care for the patient than could ordinarily be given in his home. The same conditions apply to all emergency cases, where immediate hospital observation is desirable. A strangulated hernia, for instance, has a much better chance for recovery if taken immediately to a local hospital and operated upon than if conveyed a considerable distance to a city, or if operated upon at home.

The greatest benefit to the community and to the local profession comes from the fact that the very presence of a hospital in the town stimulates at least one of its physicians to study and improve his professional ability; this in turn compels his competitors to do likewise, from the simple necessity of self-preservation. Practitioners will thus form the habit of reading the best and newest medical books and journals; they will form medical societies of their own, and also attend the societies and clinics held in the medical centers, and there learn from the masters in the profession. Experience has shown that wherever a small hospital has been established in one of these small towns, the ultimate outcome has always been for the good of the community, as well as for the physician in charge, and incidentally for all competitors.

At first one or the other, or all, of the following unfortunate contingencies may arise in the management of the hospital, and as all of these are in the main avoidable, it may be well to direct attention to them at this point.

Instead of planning these institutions to suit the conditions present in the village, they are often patterned after institutions in the great cities, and as a result the running expenses will exceed the income to such an extent that the institution will become a burden to its supporters. To overcome this difficulty the accompanying plans have been arranged. Figures 290, 291, 292, 293. It will be seen that these fill the conditions by their compactness and their arrangement, which supplies a large amount of utility at a relatively small expense. In each instance the physician's office with suitable waiting room and two examining rooms makes it possible for him to do his daily office work in the hospital building, with the advantage of enabling him to care for his hospital patients at the same time, without much additional labor, and the further advantage of making people familiar with the institution, which helps to overcome the prejudice that naturally exists in the

beginning of such an undertaking. It will be readily seen that unless the waiting room and the examining rooms are carefully planned and placed, the arrangement will not be satisfactory either to the physician or the patients. In any given case the physician in charge of the construction should study existing conditions carefully, and secure plans which have filled similar requirements satisfactorily elsewhere.

Another source of disappointment comes from circumstances closely related to those already mentioned. It occasionally happens that the physician in charge of one of these institutions will undertake the treatment of cases requiring a degree of skill far in excess of his limited experience. This is because of the fact that his early cases have been simple and consequently successfully treated. The good results obtained established a local reputation; this in turn brought the more difficult cases, which had previously sought relief in the larger medical centers. Instead of stating plainly and frankly to the patient that he does not feel prepared to treat a case of such grave importance, and that the patient's chances for recovery would be better in more skilled hands, the physician in question permits himself to be persuaded into doing that which he knows he cannot do well. A few errors of this kind will materially injure the future interests and usefulness of both the physician and the hospital.

An alternative equally bad is to keep the patient in the hospital and send for a surgeon from some large city to perform the necessary operation. This is done with the idea of securing for the hospital the income from the patient and the reputation of having cared for the case. There are two reasons why this course is not advantageous either to the hospital or to the physician. The surgeon from the city is compelled to perform a difficult operation under conditions with which he is not accustomed, with assistants not familiar with his methods, consequently he will have a lessened success, for which the home physician will in all probability be blamed. On the other hand, if the patient recovers the local physician is credited with being able to do only very simple operations. To remedy this difficulty the local physician should, in case he feels incompetent to treat a case, send it to the person he considers most competent, explaining to the patient that in a few years, when local conditions have become more thoroughly organized, he will himself be able to undertake the treatment of such cases. This will establish two facts—first, that the work done in the institution is by the physician in charge, who is willing to take all blame for bad results and who will consequently be credited for the good ones. Second, that he is willing to bear the financial

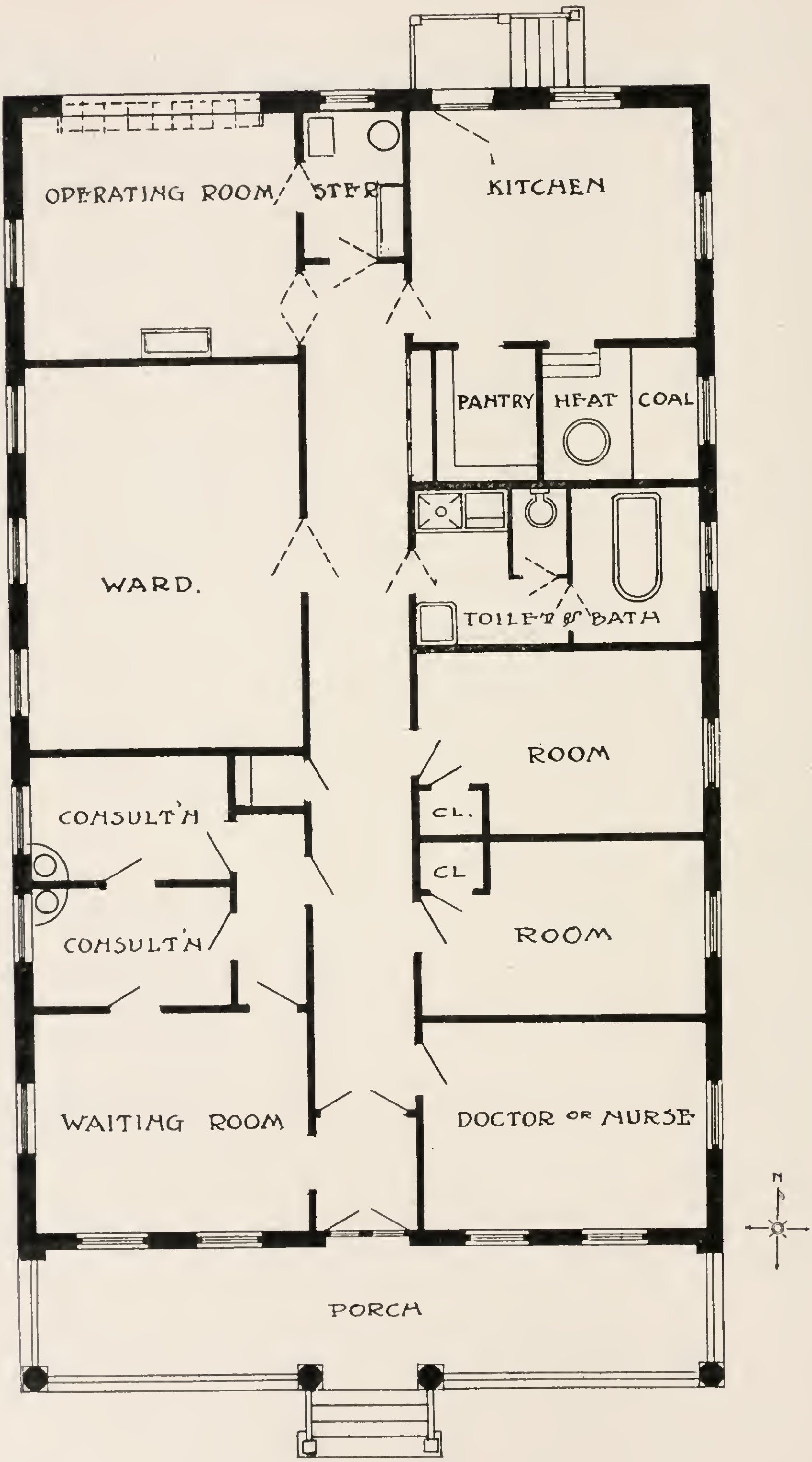
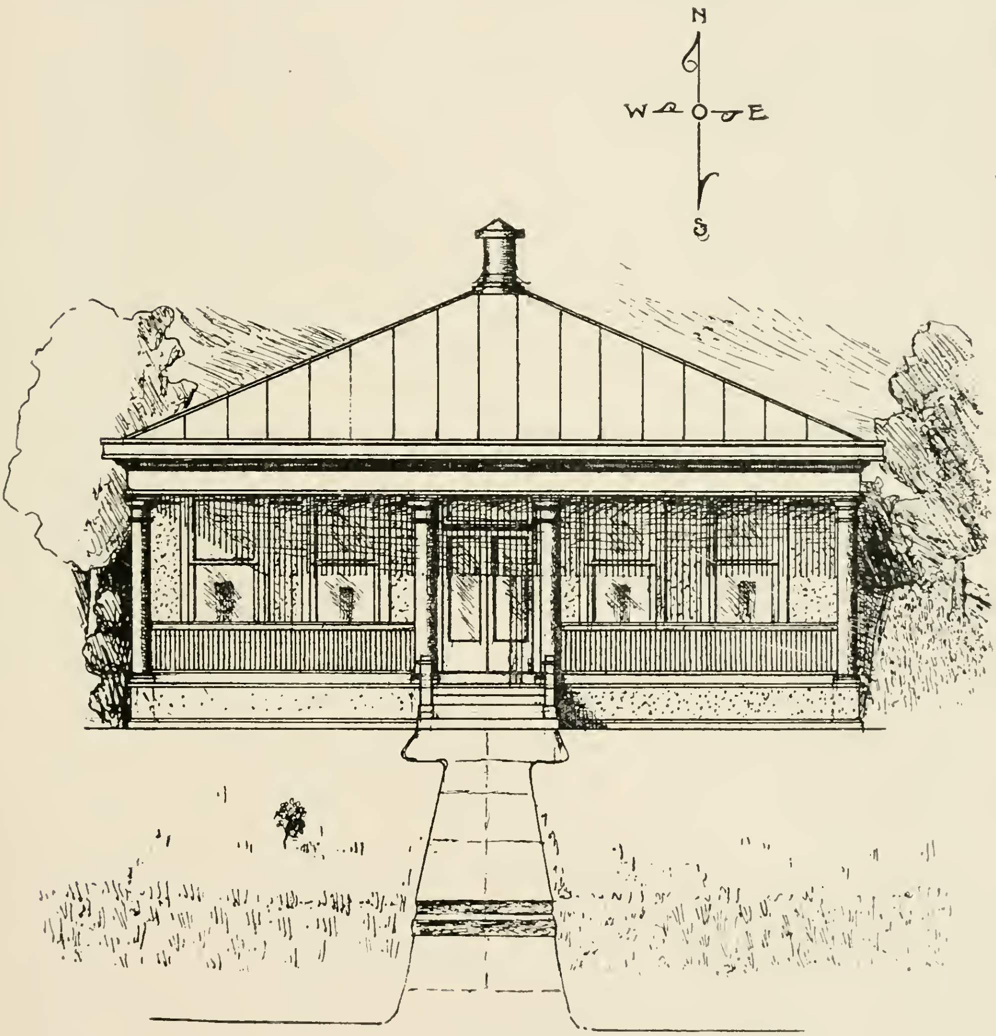


FIG. 292.
Meyer J. Sturm, Architect.

loss incurred by sending away patients who can be better treated elsewhere. At first it may seem as though this could not result in prosperity either to the physician or to the institution, but it has been tried and the experiment has shown quite the opposite to be true.

So far these hospitals have prospered only when conducted by individuals. If built by the community there are then too many



ELEVATION

FIG. 293.

interests, too many persons who know nothing about hospital management, who will try to have an important hand in the affair.

An ideal arrangement would be a combination between the community and all of the reputable physicians located in the village. But local jealousies would probably make this arrangement

impossible, although ultimately it may become necessary for the various physicians to work together in a common village hospital, or each physician may be compelled to establish his own small hospital.

It is often difficult for the village physician to leave his hospital and go away for the purpose of study. In order to overcome this the following plan has been employed very satisfactorily: In the large city hospitals the internes begin their service at different times of the year, some of them entering the hospital as soon as they graduate from college and some of them six months later. The young men who wait six months for their service to begin will often be glad to employ this period of waiting by substituting for a country doctor while he is away doing post-graduate work. This insures for the physician a substitute with ability, and also protects him from the loss of any of his practice, as the substitute will at the end of the prescribed time return to the city to fill his hospital appointment. It is much better to keep a hospital open throughout the year in this manner than to close it while the physician in charge is away on a vacation.

If the hospital is very small it will require but one nurse, and she may serve as office assistant when there are no severe cases under care. In this way the physician can afford to employ a competent nurse for his institution, which will, of course, be of great benefit to it, and to his practice.

CHAPTER XXVI.

GENERAL CONSIDERATION OF HOSPITAL PLANS

It has seemed best to consider the accompanying plans in a general way, in order to make clear our views as regards the various typical hospital conditions which we have taken from different parts of the world preparatory to the publication of this volume.

These institutions will be discussed in the order of their construction, taking the oldest first. Only the institutions that are typical, and that have been looked upon as models, will be considered in the discussion at this point.

The hospital represented in Figure 294 was built in Paris sixty years ago. When one remembers the time of its construction it is difficult to imagine a more perfect plan. The capacity of the hospital was about as large as could be handled by one administration. The pavilions were so arranged that every ward and room had sunlight at some time of the day; they were sufficiently far apart to admit of the sunning of the grounds surrounding the pavilions, which prevented dampness, and the entire plant was sufficiently compact to make the administration fairly economical. The building was constructed of stone and brick and was consequently fireproof (fireproofing was at that time unknown). There were no elevators, but comfortable stairs were conveniently located, and the building, though three stories in height, was easily accessible. The administration department and the offices are in the front central portion of the building facing the street. The amphitheatre where clinics were held is also in this portion of the building. At this time there were no street cars in Paris and the system of local transportation was too imperfect, and too expensive, to be used by the working classes, consequently it was necessary to have the building at a point accessible to the laboring population of the city. Moreover, Paris was at that time a walled city, which made it practically impossible to have a hospital located in the suburbs. The central location made it possible to secure upon the staff of the hospital members of the medical faculty of the University of Paris, and the patients who went to this institution for treatment were certain to have the care of the most capable men in this great medical center. After a thorough study of the plan, and the conditions at the time they were made, one must

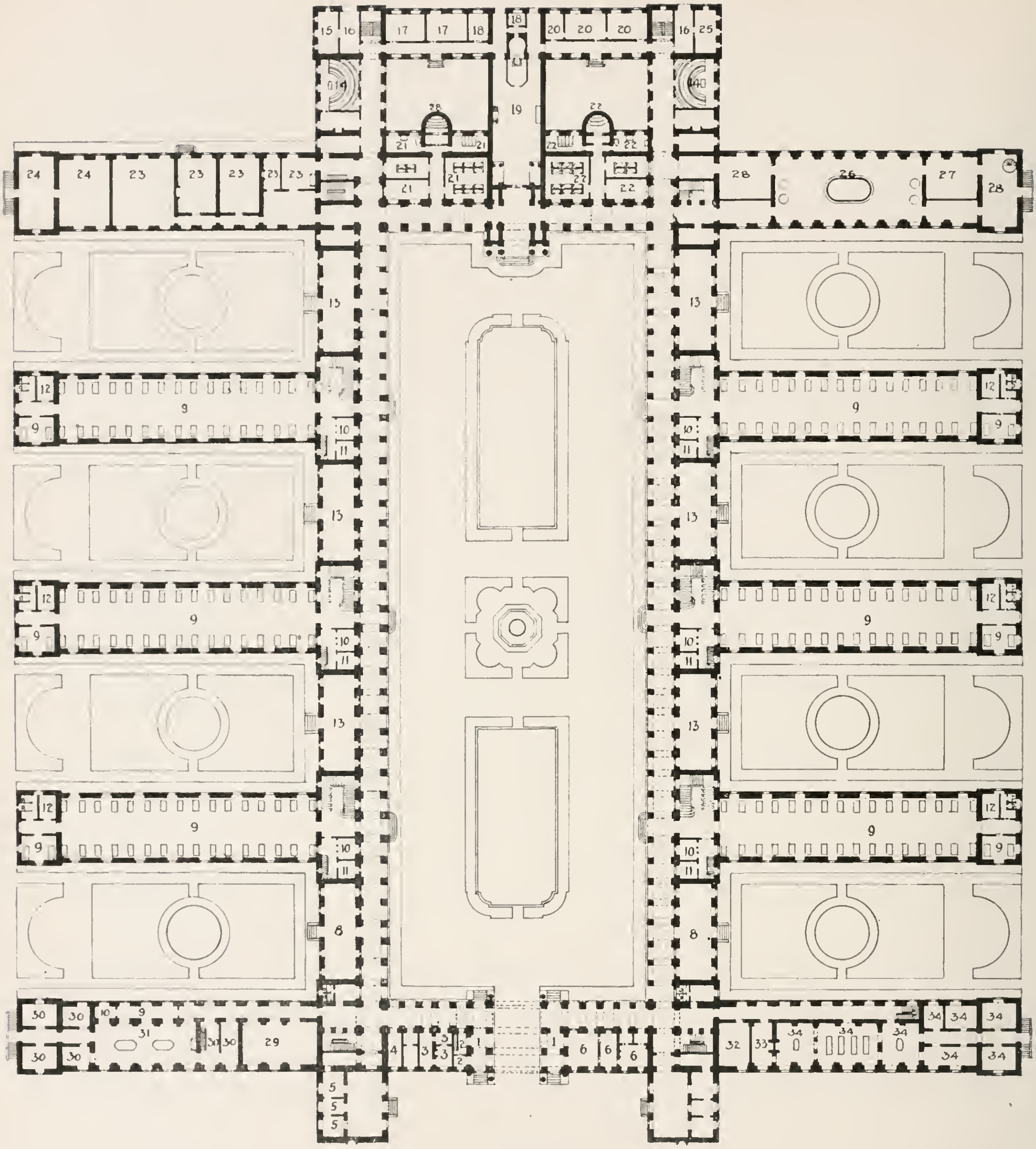


FIG. 294.

LARIBOISIERRE HOSPITAL, PARIS, 1846. 606 BEDS.

Administration.—1. Main entrance. 2. Porter. 3. Business office. 4. Physician in charge. 5. Policlinic. 6. Bureau of directors. 7. Physician's room.

Pavilions—8. Library. 9. Ward. 10. Sister. 11. Pantry. 12. Soiled linen. 13. Dry room. 14. Operation room.

Service Buildings—15, 25. Stable. 16. Wagon shed. 17. Lockers. 18. Sacristy. 19. Chapel. 20. Morgue. 21. Female baths. 22. Male baths. 23. Sisters' living quarters. 24. Store room.

Laundry—26. Laundry. 27. Dryer. 28. Stores.

Kitchen Department—29. Employes' dining room. 30. Store room. 31. Kitchen.

Drug Store—32. Assistant apothecary. 33. Apothecary. 34. Drug store and laboratory.

FIG. 295.

HOSPITAL RENKIOI ON THE DARDANELLES, 1855-56. 2,250 BEDS.

DESCRIPTION OF FIG. 295

B1, B2, B3, Ba. Pharmacy. C1, C2, C3, Ca. Stores. D. Kitchen. F. Officers' quarters. G. Office. K. Kitchen. L. Laundry. M. Residence of lady. N. Nurse's home. O. Nurse's home. P. Chief engineer. Q. Paymaster. R Residence of Greek workmen. S. Residence of Greek workmen. T. Mortuary. U. Stables.

consider this one of the most admirable great hospital plans in the world.

One of the oldest of these institutions, Fig. 295, has for more than half a century been especially admired because of its unique location in full view of the ocean on two sides. It is also remarkable because of its size. The hospital was built in 1855, and has a capacity for 2,250 beds. It is composed of 86 distinct pavilions, all one story in height. These pavilions are placed in three groups, each of these groups forming virtually a separate institution, with separate kitchen, drug-room and storeroom for provisions for each. The entire institution is formed on the "barracks" plan, the climate permitting of this method of construction. The distances between the buildings are sufficient to expose all the windows to the sunlight, and the conditions of the soil, as well as the location of the hospital, are all favorable to the best natural drainage. A number of small buildings made perfect isolation possible long before the nature of infection was known. For tropical countries, and for countries subject to earthquakes, this plan with the installation of modern plumbing, and a slightly greater separation of the barracks, would still be considered very satisfactory, especially if cheap labor were available.

The advantages in this variety of hospital may be briefly stated as follows: It may be cheaply constructed; the inexpensive windows and doors, while they protect the patients from the sun, virtually leave them exposed to the open air all day and all night. There is no danger from fire, even with the cheapest wooden material; the food for patients consists chiefly of rice gruel, or similar nutrient, which can easily be delivered to patients even though the distances from the kitchens are considerable.

This plant would be especially suited for municipal hospitals, insane asylums or hospitals for consumptives. Protection against flies, mosquitoes and other insects should be perfect, and the plumbing should, of course, be carefully studied. For institutions in colder parts of the world a plan in any way similar to this would be extremely bad, except for emergencies as in case of war, disastrous fires in a great city, or in severe epidemics.

The objections to such a plant in colder climates are as follows: First, in whatever direction one placed the lines of these buildings, there would always result an amount of shadow upon

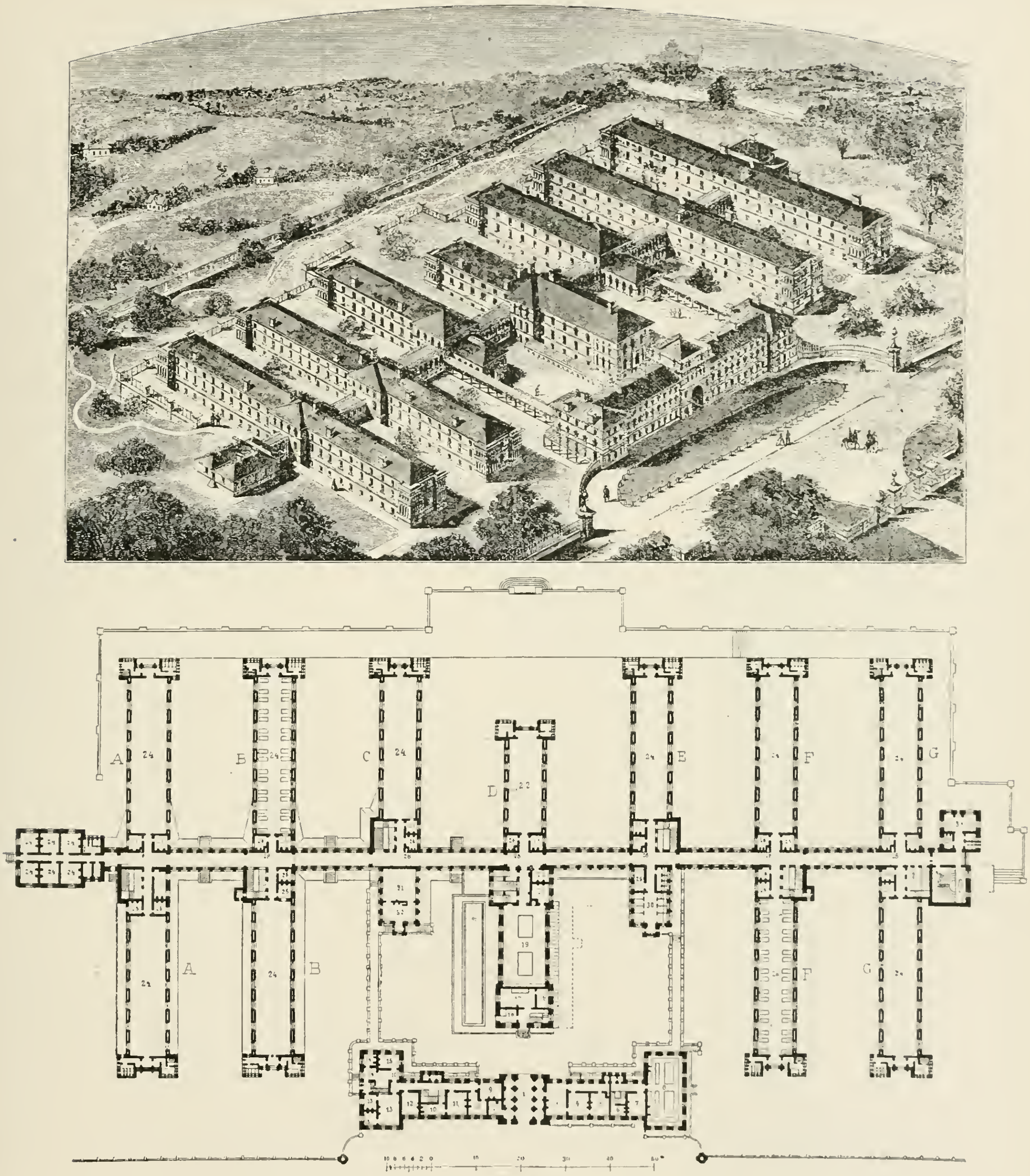


FIG. 296.

HERBERT HOSPITAL, NEAR WOOLWICH, 1859-64. 658 BEDS.

1. Entrance. 2. Porter. 3. Waiting room. 4. Exam. room. 5. Surgery. 6. Nurse's laundry. 7. Mending laundry. 8. Clean linen. 9. Director. 10. Clerk. 11. Chief physician. 12. Registry. 13. Captain of orderlies. 14. Sergeant Major. 15. Paymaster. 16. Chief cook. 17. Steward 18. Clerk. 19. Library. 20. Librarian. 21. Porter. 22. Day room. 23. Officer's dwelling. 24. Ward. 25. Nurse. 26. Pantry. 27. Washroom. 28. Elevator. 29. Dressing room. 30. Bath. 31. Pharmacy. 32. Drugs. 33. Operating room. 34. Amphitheater.

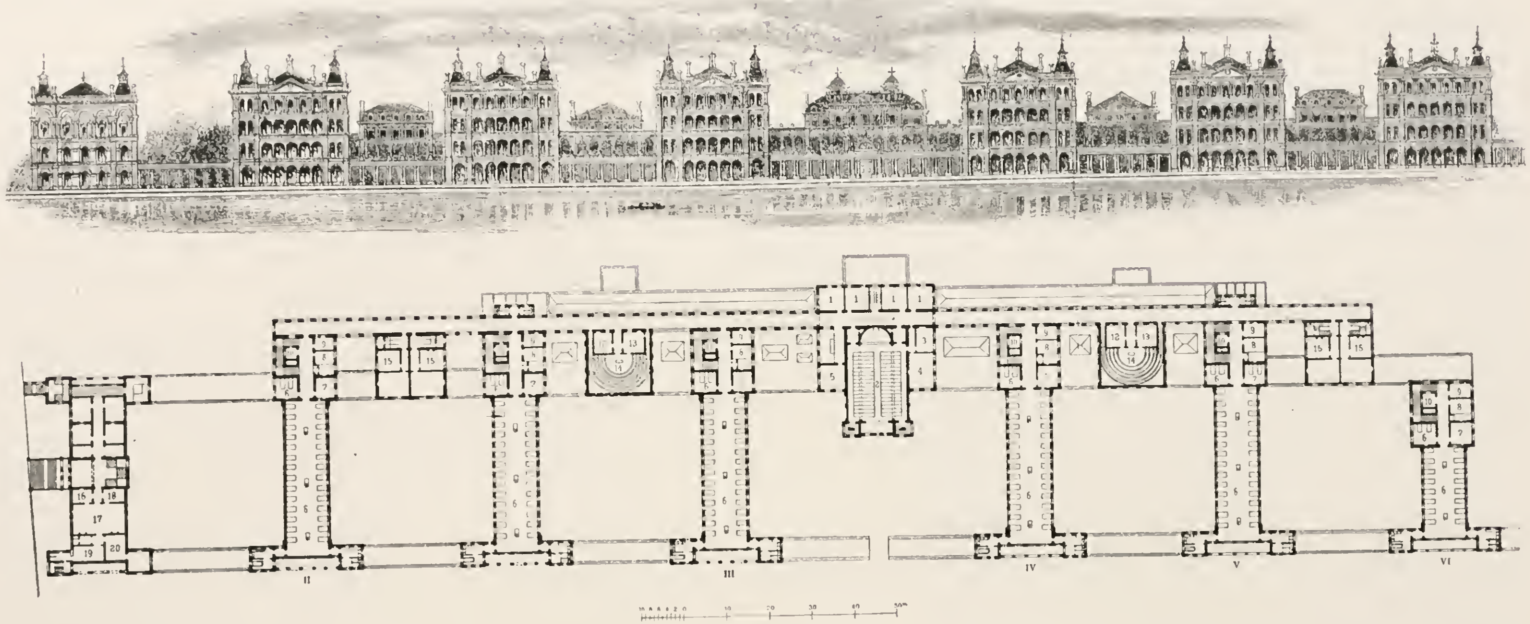


FIG. 297.

ST. THOMAS HOSPITAL, LONDON, 1866-71. 588 BEDS.

1. 12. Physician's room. 2. Chapel. 3. Vestry. 4. Consultation room. 5. Committee room for physicians. 6. Ward. 7. Nurse's room. 8. Pantry. 9. Consultation room. 10. Elevator. 11. Air shaft. 13. Waiting room. 14. Amphitheater. 15. Officer's room. 16. Porter. 17. Nurse's room. 18. Office. 19. Treasurer's room. 20. Officer for admission.

the surrounding buildings sufficient to cause a harmful degree of dampness. In order to fully appreciate this statement it will be well to refer to Atkinson's Diagram of Shadows, Figs. 9 to 20. Second, the cost of construction would be extremely high, because of the necessity of making the walls proof against cold and winds. Third, the amount of room exposure would be enormous. Fourth. the expense of heating such a plant would be excessive. Fifth, it would be practically impossible to deliver food palatable and hot to the distant pavilions. Sixth, the cost of keeping the long corridors clean would be very great. Seventh, all of the patients would be located near the ground where the air is dampest, and least hygienic. Therefore, the general idea represented in this plan may be recommended for tropical countries, earthquake regions or the dry plains of the southwest portions of the United States.

The next great hospital (Fig. 296) in time of construction, is the Herbert Hospital, near Woolwich, built in 1859-64, and planned to contain 658 beds. A glance at the ground plan of this institution shows that its construction was carefully determined as regards sunlight and natural ventilation. The choice of location outside the city, upon an elevation, is most admirable. The building is constructed with a high basement, and two stories above, producing conditions which were quite ideal before the time of fireproofing and elevators. The buildings are connected with a central corridor, which is but one story in height, in order to prevent unnecessary shadows upon the ground. The pavilions are far enough apart to allow of the perfect sunning of the grounds, and still near enough together to permit a relatively economical administration for an institution of this type. For municipal hospitals, occupied largely by factory employes who do not object to large wards, such a plan must be looked upon with great admiration, considering the time of its construction.

Because of its location on the banks of the River Thames, opposite the House of Parliament, Figure 297, represents the best known hospital ever built upon the several storied pavilion plan. Aside from these features it is remarkable for its great architectural beauty. The pavilions are a sufficient distance apart to insure an abundance of air and sunlight; they are all connected by corridors; the bath rooms are at one extreme of the pavilion, at the other end are isolation rooms, nurses and service rooms, and consultation rooms. Considering the time when it was built, the plan must be looked upon as practically perfect. Under present conditions, with the possibility of easy and comfortable transportation, it is likely that better plans from an economical as well as hygienic standpoint, could be made. An ideal institution would

be one of this kind placed upon an elevated portion of land within ten miles of the city limits. It could be easily reached by automobile ambulance, or ambulance cars, which could be run from a central receiving hospital, making as many trips each day as would be required to carry the day's accumulation. This would transport the patients out of the smoke-laden city atmosphere. The

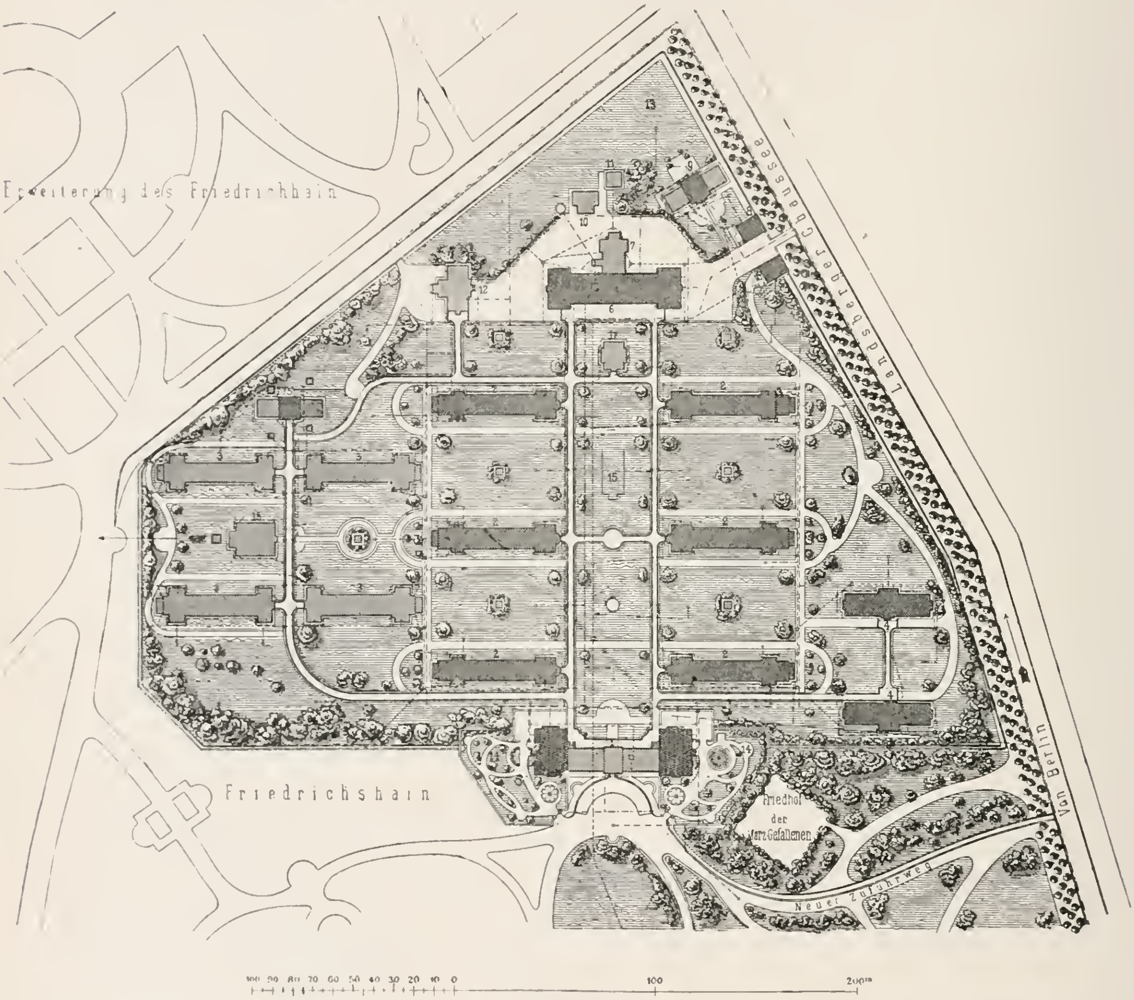


FIG. 298.

GENERAL CITY HOSPITAL AT FRIEDRICHSHAIN, BERLIN, 1868-74. 624 BEDS.

1. Administration. 2, 3, 4, 5. Hospital buildings. 6. Management. 7. Boiler house. 8. Porter's lodge. 9. Nurse's home. 10. Disinfection. 11. Icehouse. 12. Mortuary. 13. Drying place. 14. Officer's garden. 15. Chapel. 16. Operating building. 17. Bathhouse.

6. Pavilions for medical patients. 4. Pavilions for surgical patients. 2. Pavilions for contagious patients. Double pavilions for diphtheria.

land occupied by the present building if sold would bring a sufficient sum of money not only to construct a new hospital, but enough furthermore to support such an institution for an indefi-

nite period, if invested in proper securities. No doubt such plans will ultimately materialize, but for a centrally located institution, the general idea of this hospital must continue to stand as an excellent model.

The hospital shown in Fig. 298 was built just before the antiseptic period. At that time there existed a general feeling among scientific medical men that a definite substance passed from one patient to another, causing the second patient to become afflicted with the same disease as the first; an affection that would attack patients successively in one building, but would not affect those in a separate building. Pasteur was hard at work at this time laying the foundation for our present knowledge concerning infection and contagion, but everywhere the practical subject of isolation was becoming recognized. In order to secure the greatest amount of isolation, and still attain as perfect hygienic conditions as possible, this hospital was built as illustrated in Fig. 298.

The buildings were scattered in a beautiful park as far apart from each other as the available amount of space would allow. They were screened from the surrounding streets by intervening shrubbery. The buildings were all independent, low pavilions. illustrated in Figures 296 and 297. In the light of modern achievements, the objections stated in discussing the plan in Figure 295 all hold good here. A compact building six or more stories in height could be constructed for a little more than one-half the cost of this institution, and it could be maintained at an expeuse of approximately 60 per cent. of the running expenses of a building upon the plan 298. It must be remembered, however, that this building was constructed before the era of fireproofing, before the introduction of elevators and before the cause of infections and contagious diseases had been discovered. It was not then known that the air in the sixth story of a building contains fewer micro-organisms than that of the first story. With the knowledge available at the time this hospital was constructed, nearly forty years ago, one must consider it a remarkable production.

Compared with the hospital just described, that illustrated in Fig. 299 is an unsatisfactory example of a similar system. There is much greater concentration with the resulting convenience in management. All of the pavilions are arranged so they can be easily reached from the corridor which passes along one end of each pavilion, with the exception of four pavilions in the semicircle. At the north end of the building all the pavilions extend from east to west, thus exposing one side to the sun during the the entire time from 8 a. m. to 4 p. m. during the whole year. and exposing the ends either to the morning sun from 8 a.

m. until 12 m., or the afternon sun from 12 until 4 p. m. The fact that one entire long side of the building receives no sunlight whatever during six months in the year is not so great an objection as might be supposed, because the entire building, with the exception of the end portion, composes an open ward which is consequently sufficiently sunned from the windows on the south side. The objection against extending a building from east to west, with a central corridor with rooms and wards on either side, is, of course, not valid when applied to one in which the entire space is given to one large ward.

From a standpoint of economy of conduct this form of construction is better than that of the hospital illustrated in Figure 298.

There is another and perhaps more serious objection to this plan. The pavilions are all a short distance from the street; they are exposed to the street noises and the street dust; and the patients are compelled to breathe this unwholesome air. If this institution were an eight or ten storied building, placed in the middle of the plot of land, every room and ward would have a view of the beautiful Thiergarten, the trees and shrubbery, and the patients could live in an atmosphere free from dust, away from the noise of the street, with all conditions far superior to those in which they now exist.

Of all American hospitals the Johns Hopkins has received most attention as a model, because of the study which was given preparatory to the completion of its plans. These preparatory studies were incorporated in a collection of essays which have served as a guide to American architects for a period of nearly thirty years. At the time the plans were drawn they were as perfect as it was possible to make such plans with all the available facts. The location of the hospital on high land is ideal; the amount of land ample; the spacing for air and sunlight perfect. At a time when facts concerning infection and contagion were but little known; when there was no fireproofing, no elevators; when nothing was known concerning the difference in the condition of the air at various elevations; and before any attention had been directed toward the dangerous effects of street dust, it is difficult to imagine a more perfect scheme.

At the present time the expense of cleaning, heating, lighting and keeping in repair a building constructed in this way, would be at least 40 per cent. more than in a single many-storied building, with a separate building for the boilers, electric power, mortuary, laundry and one for nurses and employes, and another for contagious diseases. The high location of this building makes the fact

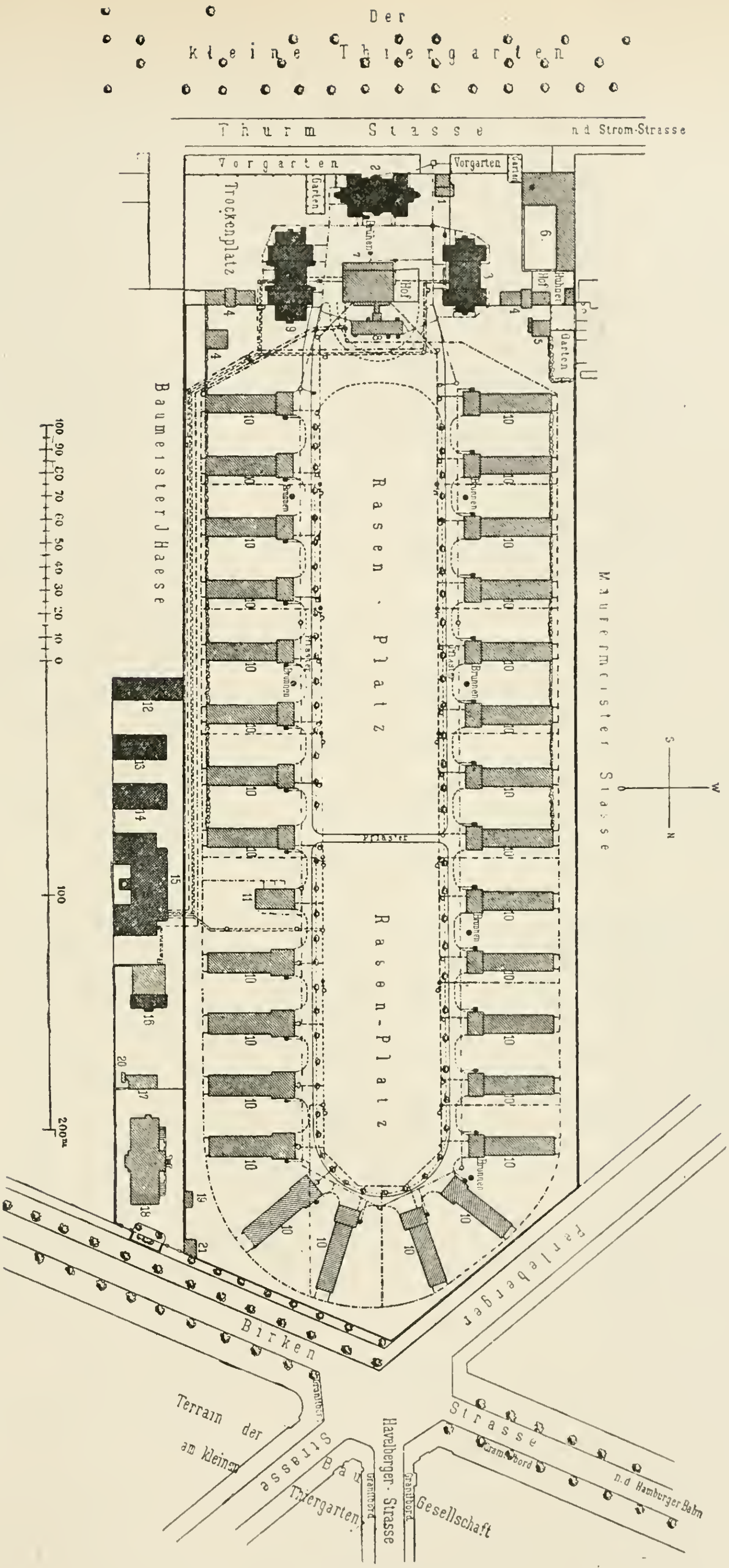


FIG. 299.

CITY HOSPITAL IN MOABIT, BERLIN. 811 BEDS.

1, 21. Porter's lodge. 2. Administration building. 3. Kitchen. 4, 13, 14. Shed. 5. Icehouse. 6. Department for protection against fire 7. Machine house. 8, 16. Disinfection houses. 9. Laundry building. 10, 11. Patients' buildings. 12. Workshops. 15. Boiler house. 17. Stable for animals for experimenting. 18. Mortuary. 19. Outhouse. 20. Scales.

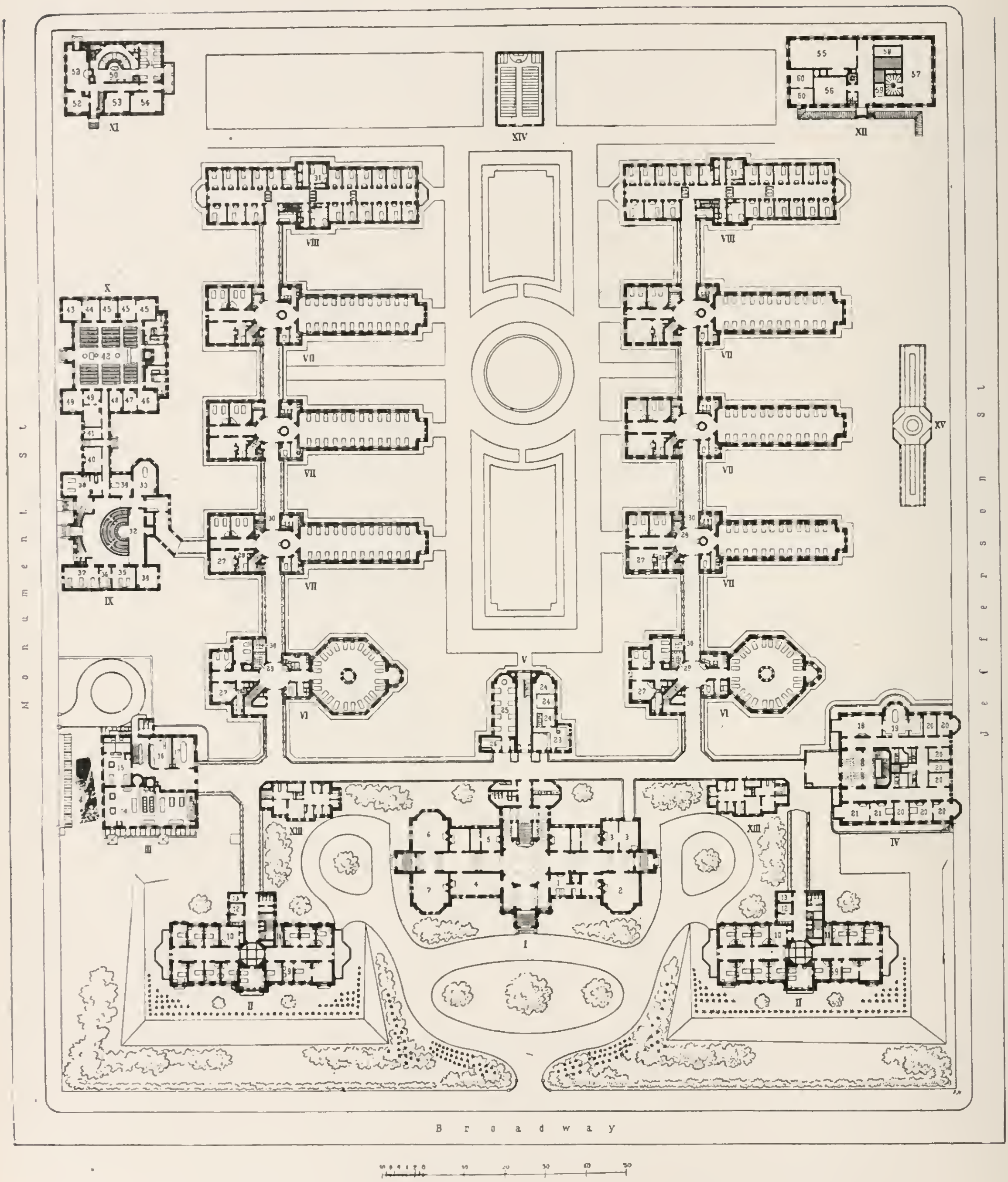


FIG. 300.

JOHNS HOPKINS HOSPITAL, 1876. 378 BEDS.

DESCRIPTION OF FIG. 300

I. Administration—1. Office. 2. Director. 3. Waiting, exam. and matron. 4. Receiving room. 5. Superintendent nurses. 6. Library. 7. Superintendent.

II. *..*..*..*..*..*.. 9. Dressing room. 10. Kitchen. 11. Clean linen. 12. Bathroom. 13. Elevator.

III. Kitchen—14. Kitchen. 15. Pantry. 16. Storeroom. 17. Dining room.

IV. Nurses' Home—18. Parlor. 19. Library. 20. Head nurse. 21. Superintendent of nurses.

V. Drug House—23. Pharmacy. 24. Druggist. 25. Dining room. 26. Tea room.

VI., VII. Patients' buildings—27. Dining room. 28. Pantry. 29. Clean linen. 30. Patients' clothing.

VIII. Isolation Building—31. Nurses' room.

IX. Operating Building—32. Amphitheater. 33. Operating room. 34. Physicians' room. 35. Recovery room. 36. Nurses. 37. Isolation room. 38. Admission of injured. 39. Anaesthetizing room. 40. Gynecological room.

X. Poliklinic—41. Porter. 42. Nurses' room. 43. Diseases of throat. 44. Diseases of children. 45. Internal diseases. 46. Venereal diseases. 47. Dermatological diseases. 48. Neurological diseases. 49. Eye and ear diseases.

XI. Pathological Institute—50. Amphitheater. 51. Mortuary. 52. Bacteriological institute. 53. Examination. 54. Waiting room, library.

XII. Laundry—55. Patients' laundry. 56. Officers' laundry. 57. Ironing room. 58. Drying room. 59. Drying room for officers laundry. 60. Repair of bedding.

XIII. Chapel.

XIV. Bathhouse.

XV. Conservatory for Plants.

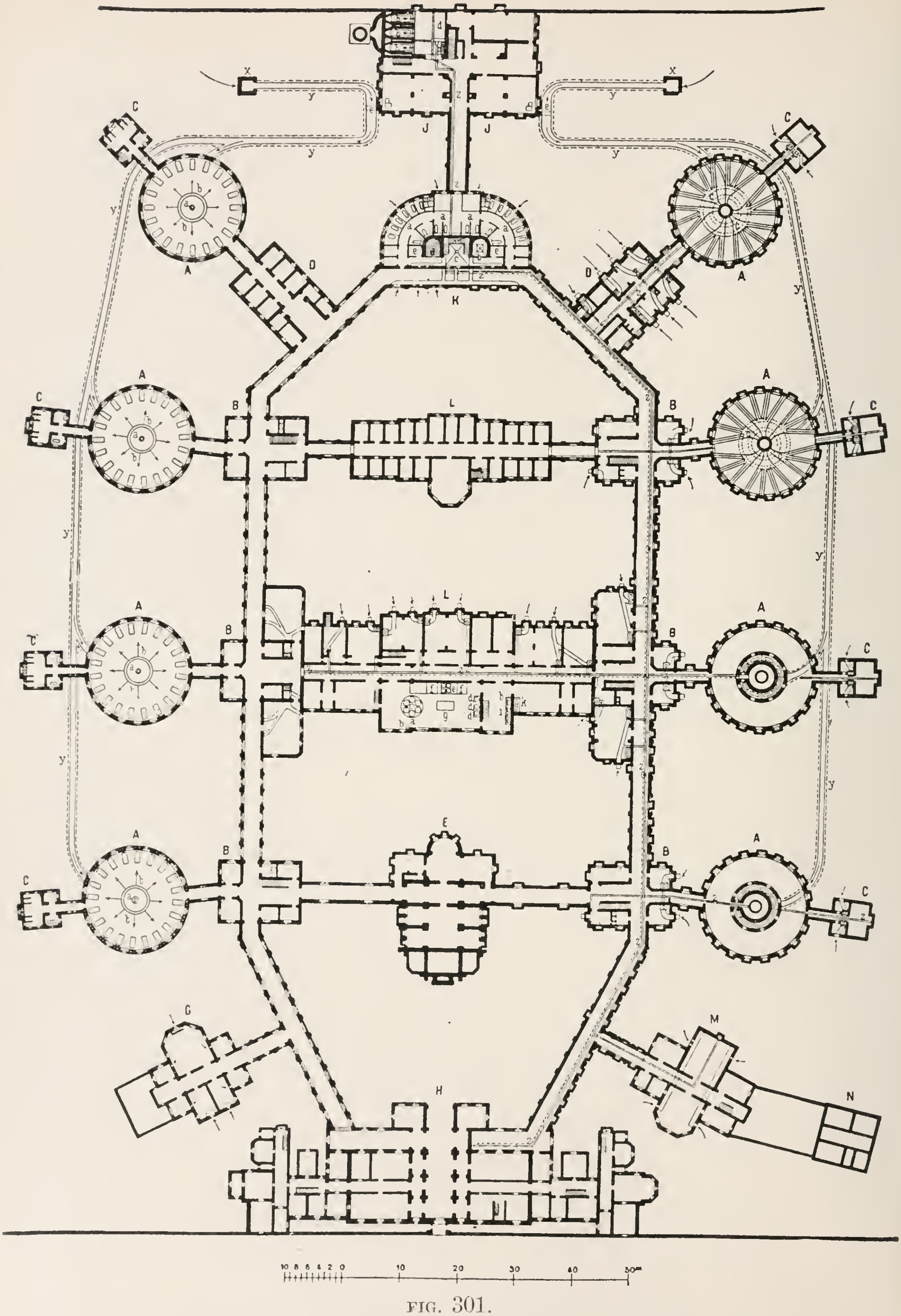


FIG. 301.

GAUSTHAUS STUIVENBERG, ANTWERP. 1878. 388 BEDS.

DESCRIPTION OF FIG. 301

A. Patients' pavilion. B, C. Accessories. D. Private wards. E. Chapel. G. Operating house. H. Administration. J. Boilerhouse and steam laundry. K. Baths. L. Sisters' home. L. Drug room and kitchen. M. Mortuary. N. Stables. e, e. Ventilator. x, x. Ventilator shaft. y. Forced ventilator shaft. z. Steam and condensed water tubing.

that most of the patients are housed in the first story less objectionable than it would be were the buildings not elevated above the surrounding structure.

About the time that the last mentioned hospital was being planned a very unique institution was undertaken in Antwerp, as illustrated in Figure 301, the idea being to supply an institution in which all of the wards formed perfect circles. These pavilions are connected with the central administration building. with the kitchen, mortuary, bath, toilet and operating pavilion by means of corridors. The objection here lies in the expense of keeping clean and in repair the great amount of wall space, floor space and windows, as well as in heating the unused surfaces which are exposed to the weather. Another serious objection is that the food must be transported such long distances before it can be delivered to the patients. In a tropical country, with cheap service and cheap, simple food, this plan might be considered ideal, but in the cold climate of Antwerp it would not at the present time be reasonable to construct such a building.

This is the last plan (Fig. 303) to be described of a hospital built in the pre-antiseptic period. From the standpoint of hygiene it is undoubtedly correct. No matter in which direction the building might be placed, the central ward will receive an abundance of light from the south side. If the building extends from north to south, one side of the ward is flooded with sunlight during the morning hours, and the other side in the afternoon. The feature which seems entirely unreasonable is that for a ward containing sixteen patients two pavilions should be sacrificed for operating purposes. Aside from this, the lighting of the operating pavilion is remarkably bad. This plan would be most excellent if the building were situated with its long axis from north to south, and the northern end utilized for an operating pavilion, which would be lighted entirely from the north side. The portion of this end marked 2 and 4 could be changed into a recovery ward, and the portion marked 1 in the opposite wing into a day room for patients just recovering from an operation, so they would not disturb the patients in the general ward. This would also enable the patients who are convalescent to amuse themselves comfortably without disturbing the others.

The hospital illustrated in Figure 304 is the first great hos-

pital constructed after the introduction of antiseptic methods. It was patterned after the hospital illustrated in 298.

This hospital has been looked upon as a model type of a small-pavilion hospital. It contains eighty-two distinct buildings, most

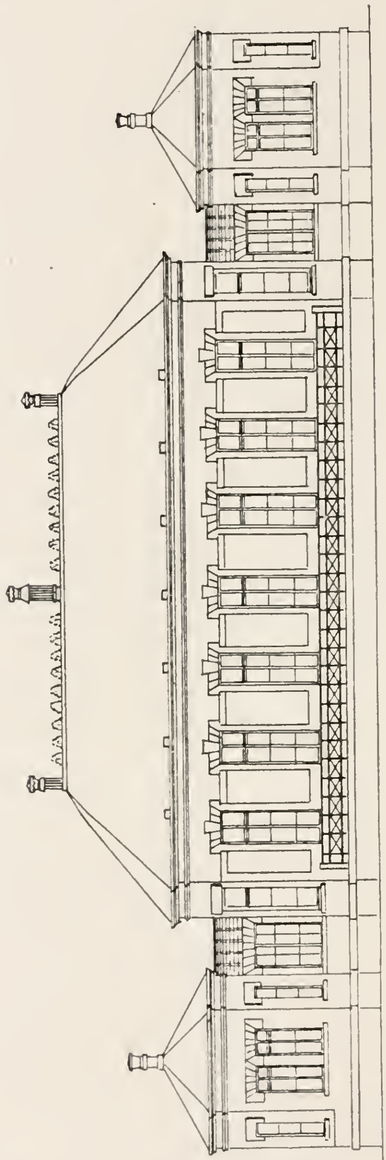


FIG. 302.
Elevation of plan. 303.

of which are one story in height, the others two stories. The plant occupies twenty-three acres of land, and still the amount of space around the buildings is not sufficient to prevent the shadows from the various buildings, together with the shrubbery, from keeping the ground too damp for satisfactory hygienic conditions.

All of the objections mentioned in reference to a hospital constructed according to Figure 298 would be valid here. The dis-

tances that have to be traversed in order to visit the patients in the various pavilions is so great that the chiefs of the departments rarely find time to make rounds in the wards, this duty being relegated to assistants.

With the present existing conditions in Hamburg this hospital could be constructed with a vast amount of saving, both as

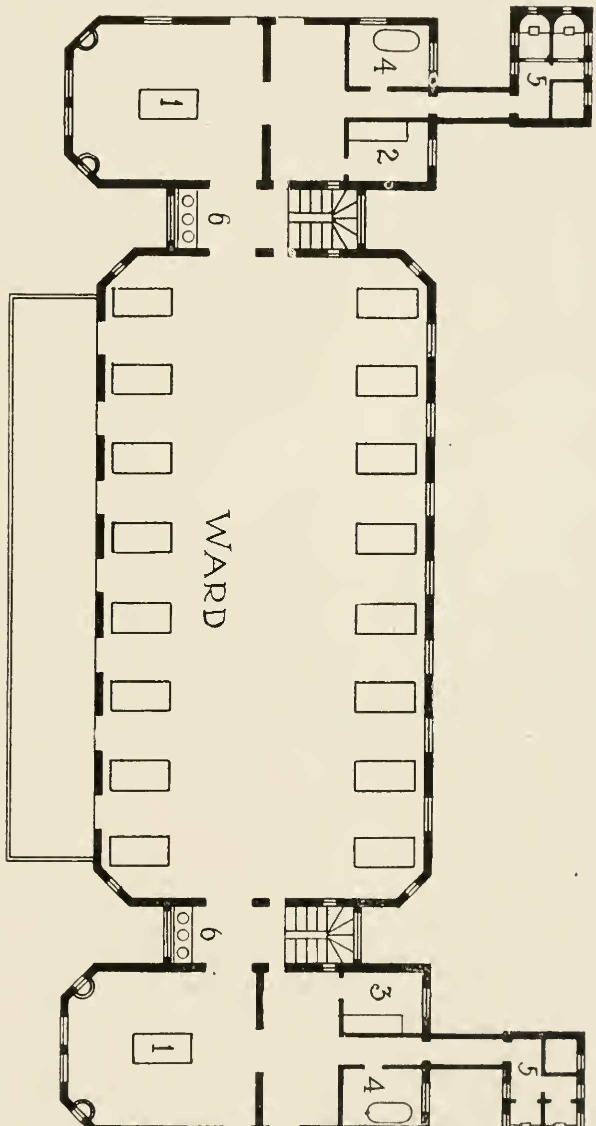


FIG. 303.

MUNICIPAL HOSPITAL ST. DENNIS, 1880. 16 BEDS.

1. Operating room. 2. Physician. 3. Nurse. 4. Bath. 5. Toilet. 6. Lavatory.

regards construction and management, if one or the other of two plans were followed. The old general hospital is located on a piece of land containing several acres, situated on the bank of a beautiful lake known as the "Alster Basin," within a mile of the business portion of the city, and on the edge of the residence portion, an absolutely ideal position. Had a ten-story building been

constructed, in which the first floor could be arranged for administration rooms, examining and receiving rooms, rooms for the resident staff, laboratories and pharmacy, the top story for operating rooms, dressing rooms, recovery rooms, kitchen and storeroom, the remaining stories for housing two hundred patients on each floor, the same capacity could have been secured, with better hygienic conditions for the patients. The cost of maintenance of such an institution would also be much less.

The second plan for similar conditions would consist in utilizing the plot of ground now occupied by placing a many-storied building in the middle of the grounds, and having the surrounding grounds laid out in the form of a park, being careful not to plant trees near enough to the buildings to cause an undue amount of moisture. This again would result in a building, and a building spot, of great beauty, and the conditions would favor a great saving both as regards management and construction.

The hospital shown in Fig. 305 was designed with a view to its future enlargement, as indicated by the dotted lines. This enlargement if made would almost double the capacity of the original building.

At the time these plans were made none of the micro-organisms producing contagious or infectious diseases had been positively identified, although the cause of pus infection and its prevention had already been published by Sir Joseph Lister, but the theory of contagion was very vague. This probably accounts for the great area over which so small a hospital was distributed. For the time of its construction it should be considered one of the best models.

Figs. 306, 307 are the first to show a tendency toward concentration, but a glance at the amount of outside wall and hall space shows it to be enormous for the very small amount of utility. The total amount of space used for housing patients is less than one-third of the entire floor space in the building.

Figure 308 is given as a beautiful example of a children's hospital built after the pavilion plan. There is one large pavilion for general diseases, a small pavilion for each one of the various contagious diseases. Aside from these there are separate buildings for teaching purposes, for examination and treatment of outpatients, a boiler house containing the laundry, sterilizing plant, and the mortuary.

This building contains the element of concentration, which aids greatly in making its maintenance inexpensive. The amount of space for air and sunlight is ample. There is a distinct objection in having wards as large as are shown in this plan. A second

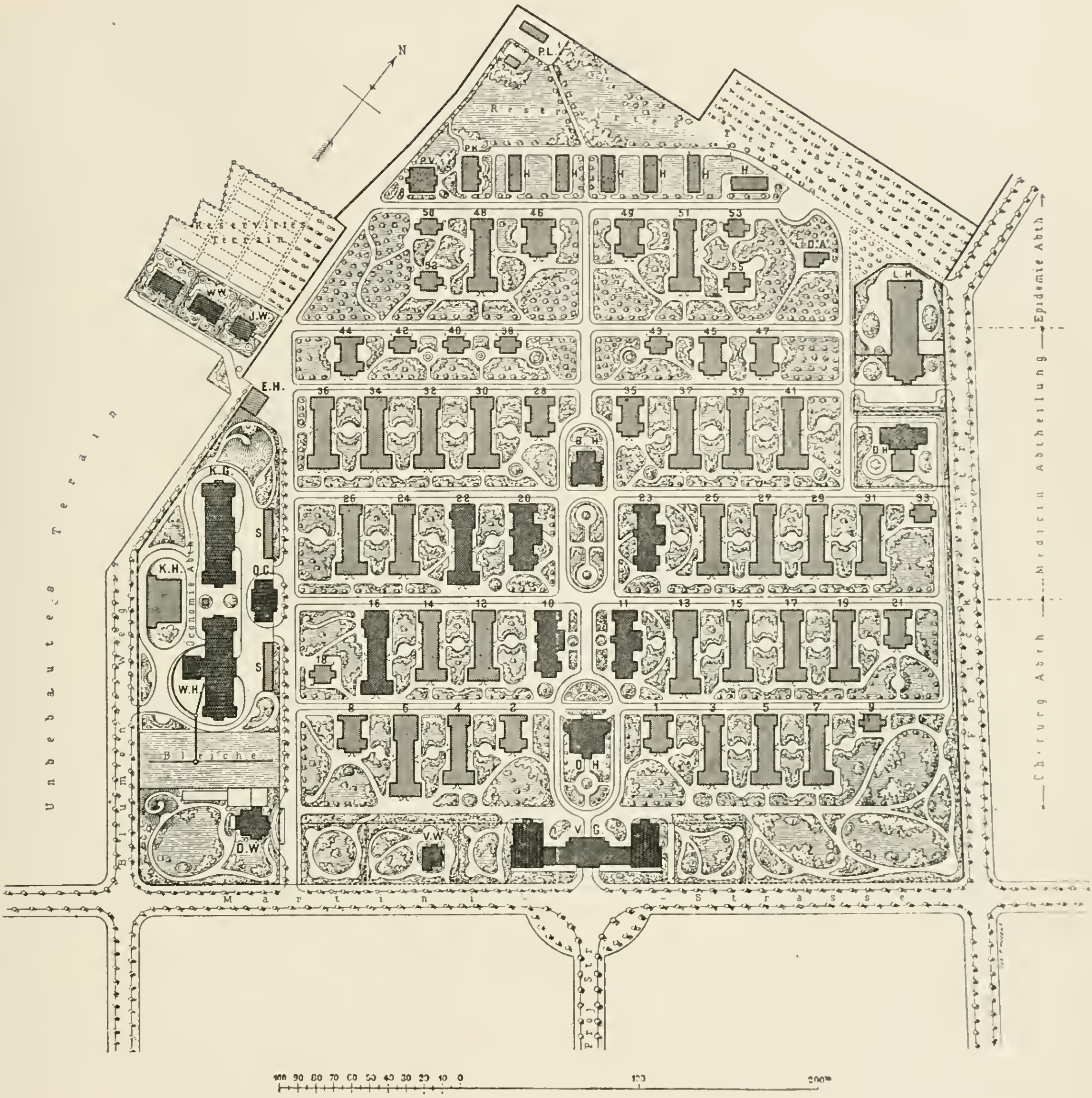


FIG. 304.

THE NEW GENERAL HOSPITAL, HAMBURG, EPPENDORF, 1884. 1,474 BEDS.

B. H. Bath house. D. H. House for delirious. D. W. House for director. E. H. Ice house. J. W., W. W., Officers' houses. K. G. Kitchen. K. H. Boiler house. L. H. Mortuary. O. G. Management. O. H. Operations. S. Warehouse. V. G. Administration. V. W. Residence of administrator. W H. Laundry 1—45. 47. Patients' pavilion.

Contagious Department—46, 48—53. 55 u. H. Patients' buildings. D. A. Disinfection. P. K. Kitchen. P. L. Mortuary. P. V. Administration.

6. Receiving pavilion. 24. Pavilions. 4. Boarders, i. e., private patients. 2. Pavilions for eye cases. 2. Pavilions for children. 1. Pavilions for insane. 5. Pavilions for isolation. 11. Isolation blocks. 5. Wooden barracks.

objection lies in the fact that the entrance to the woman's ward is through the children's ward.

Fig. 311 is the latest hospital which has been completed on the low pavilion plan. The general construction of most of the pavilions is from north to south, and the general plan of each pavilion is shown in Figure 311. The amount of space utilized for the proper housing of patients in this institution is very small as compared to the amount of floor space in each pavilion. The entire plant is as complete in every detail as it can be made. It covers an area of more than twenty acres of land; the cost of constructing the buildings is not great, when compared to the number of patients that can be housed. Although this plant is greatly scattered, the expense of maintaining it is not abnormally large. The construction was not begun until 1900, but the general outlines of the plan were established more than twenty-five years before that time, which accounts for some of its characteristic features. It is said to be by far the finest example of an institution ever built upon the small pavilion plan. It is located in the outskirts of the great city.

Fig. 312 shows a typical hospital for contagious diseases with the high and low pavilion system.

There are four pavilions, three of which are utilized for wards for different diseases, and the fourth one for an administration pavilion containing three rooms for patients who are to be kept under observation in case of doubt regarding their diagnosis before placing them in the proper ward. Were it necessary to place a definite distance between wards containing contagious diseases the plan Figure 312 would be almost ideal, because of the distance between the various buildings, although not sufficient to make the administration cumbersome. The most expensive part of the administration would be due to the care required in serving hot, palatable food to the patients, and to the work of keeping these long connecting corridors clean.

Since we know that contagion is transmitted by some form of contact only, except when the number of patients is so great that the air of a room is saturated with contagious material, it seems wise to choose another form of construction, which will be considered later in the discussion of the plan illustrated in Figures 313, 314, 315.

THE MANY-STORIED CONTAGIOUS HOSPITAL.

Fig. 315 represents a typical, many-storied hospital for contagious diseases, together with an annex containing the heating plant, dynamos for electric light and power, the laundry and the

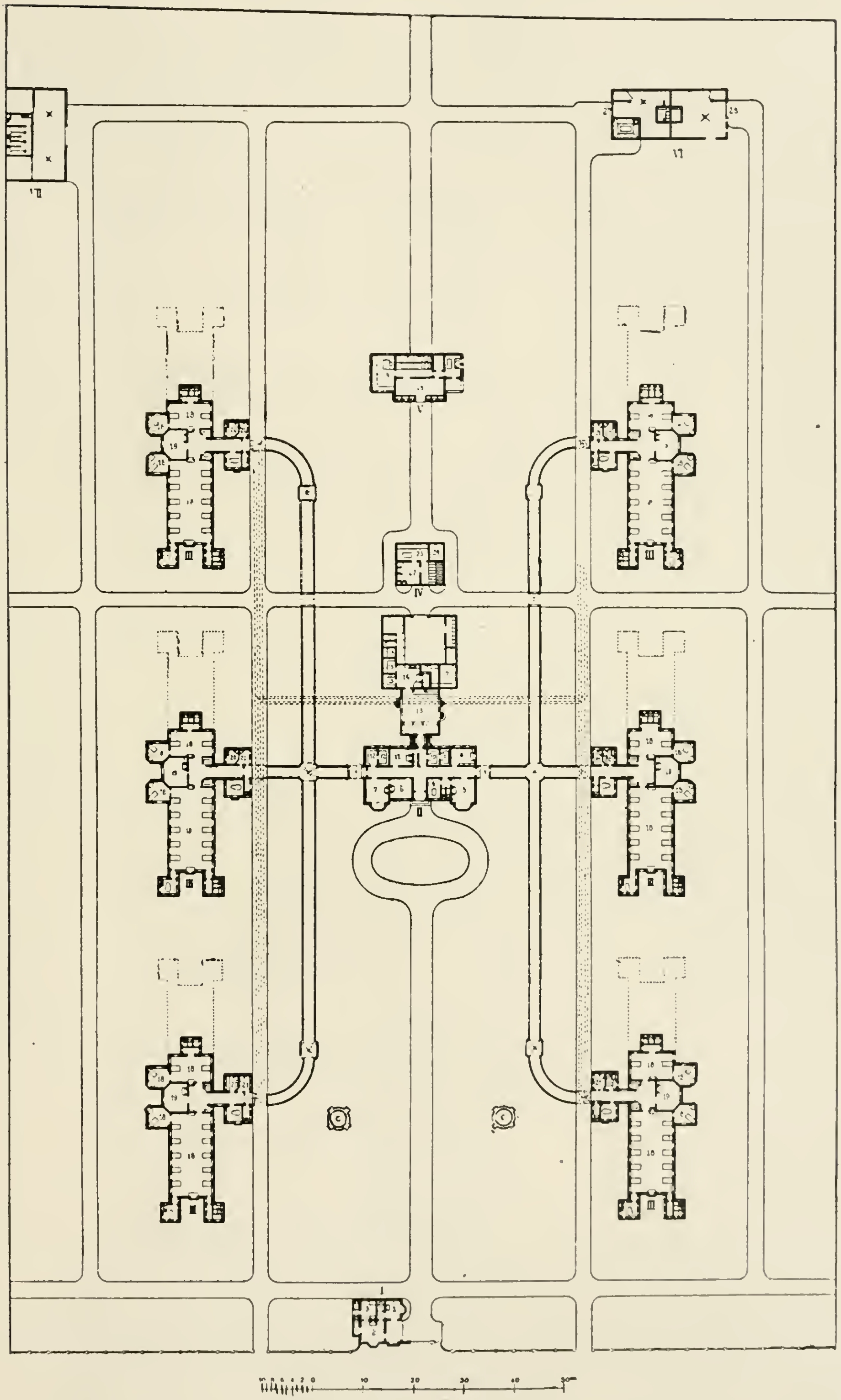


FIG. 305.

CITY HOSPITAL FOR CONTAGIOUS DISEASES AT NEWCASTLE-UPON-TYNE. 1884. 84 BEDS.

DESCRIPTION OF FIG. 305

I. Porter's Lodge—1. Waiting room. 2. Living room. 3. Kitchen.

II. Administration—4. Office. 5. Physician. 6. Matron. 7. Sewing room. 8. Pharmacy. 9. Patients' laundry. 10. General laundry. 11. Dining room for nurses. 12. Stores. 13. Kitchen. 14. Butler's pantry. 15. Pantry. 16. Polishing room. 17. Milk refrigerator. .

III. Patients' Pavilion—18. Ward. 19. Nurse. 20. Service room. 21. Waiting room.

IV. Laundry—22—24. Officers' laundry.

V. Laundry—25, 26. Patients' laundry.

VI. Disinfection—27. Entrance. 28. Exit.

VII. Stables.

Division of Patients—Six pavilions with fourteen beds each, total 84; extension, six pavilions with eight beds each, total 48; grand total, 132.

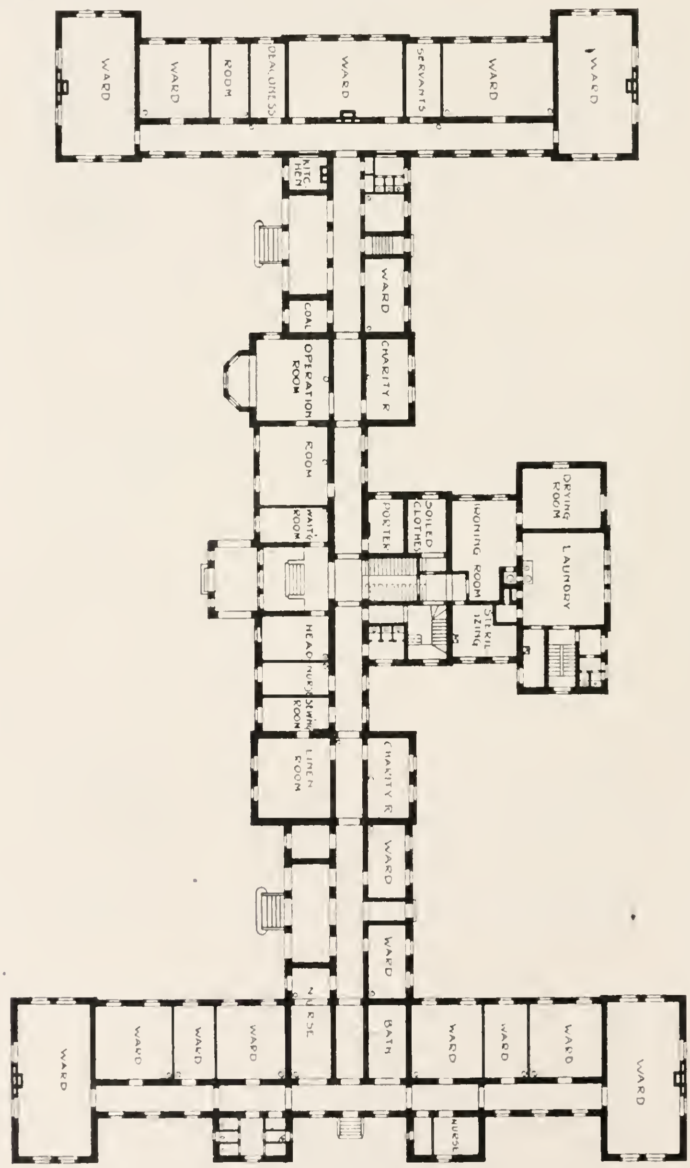


FIG. 306.

First Floor Plan. Hospital at Dessau, 1886.

sleeping rooms for the servants. The object of having a separate building for these departments is practically to provide quarters for the servants who work in the hospital proper. Unless such quarters are provided it would be difficult to secure servants, and there would always be the danger of their carrying infection from

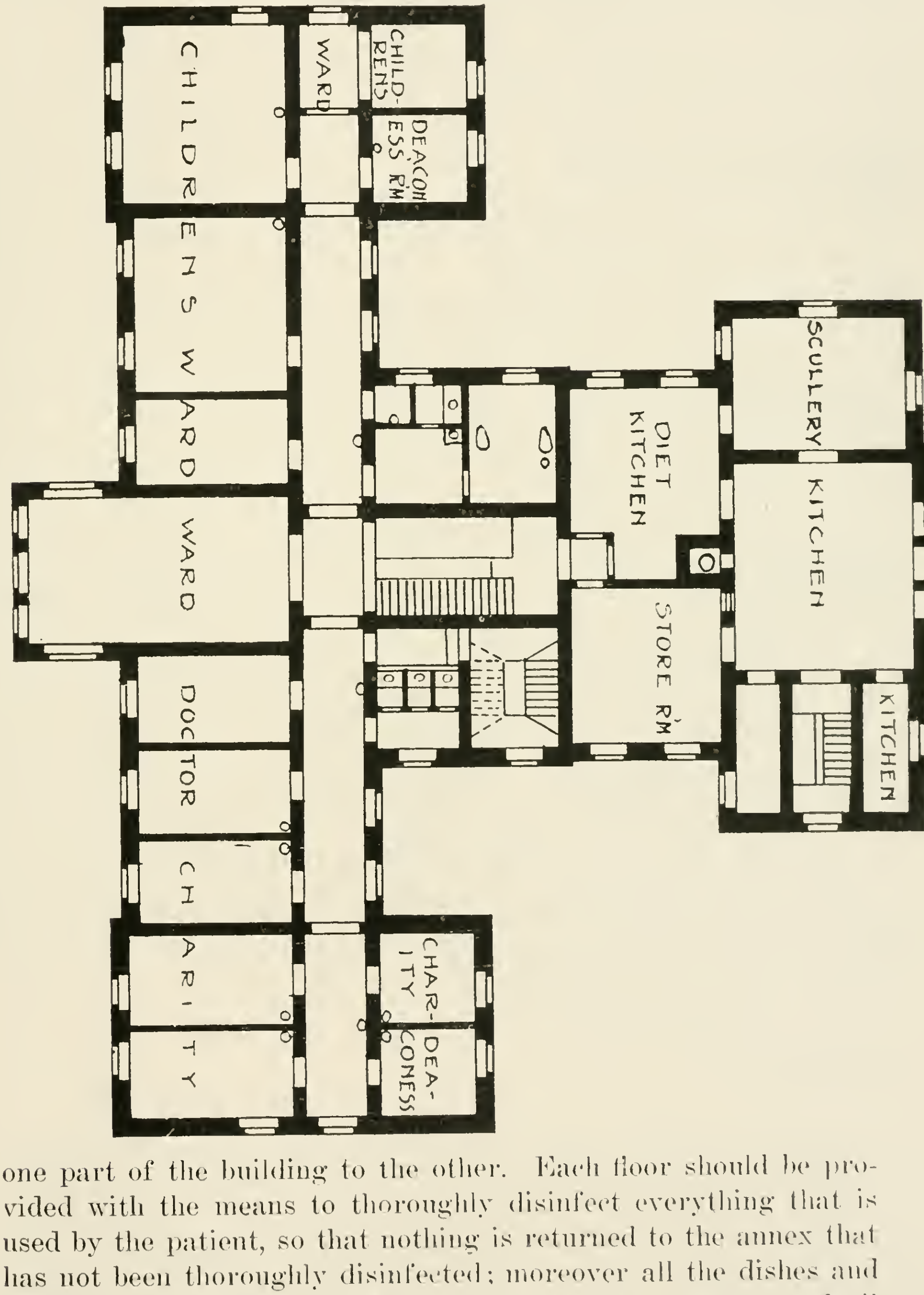


FIG. 307.
Second Floor Plat. Hospital at Dessau, 1886.

one part of the building to the other. Each floor should be provided with the means to thoroughly disinfect everything that is used by the patient, so that nothing is returned to the annex that has not been thoroughly disinfected; moreover all the dishes and cooking utensils are returned in sterilized metal baskets, and all of the linen is returned in sterilized canvas bags.

The first floor is used for the departments of administration, and contains the offices, dining room for nurses and physicians, dining room for servants, matron's room, examining rooms, operating rooms and laboratory. The direction of the building is

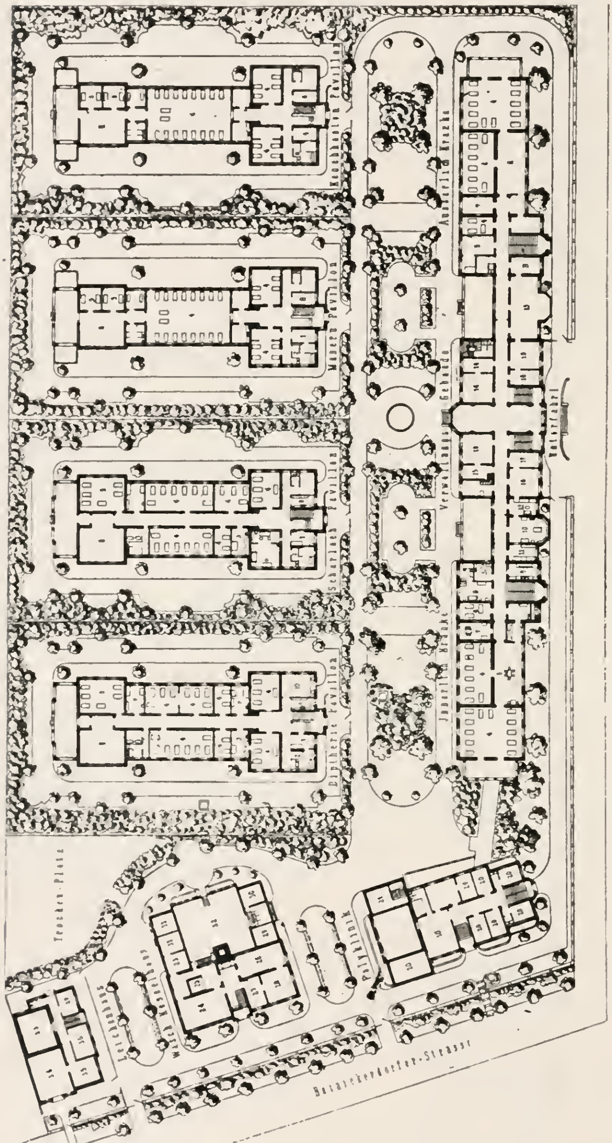


FIG. 308.

FREDERICK'S CHILDREN'S HOSPITAL, BERLIN, 1890. 258 BEDS.

Patients' Building—1. Porteress. 2. Lodge. 3. Admission. 4, 5. Ward. 6. Day room. 7, 8. Sisters' butler's pantry. 9, 12. Physicians' rooms. 10. Operating department. 11. Instruments. 13. Gymnasium.

Administration—14. Office. 15. Pharmacy. 16. Directors' room. 17. Consultation room. 18. Administration room.

Policlinic—19. Waiting room. 20. Dark room and isolating room. 21. Sister. 22. Prescription room.

Laundry and Boiler House—23. Soiled linen. 24. Washroom. 25. Drying room. 26. Ironing room. 27. Laundry. 28. Stores. 29. Wagon shed. 30. Fireman. 31. Disinfection. 32. Boilerroom.

Mortuary—33. Mortuary. 34. Storage for mortuary. 35. Workingroom. 36. Dissecting room. 37. Orderly.

north and south, and the operating room and laboratory are located in the north side of the building in order to secure satisfactory light. The elevator is placed in the square space, which is entirely separate from the main halls, first by means of swinging doors, separating the general corridor into three portions, the central portion being the space occupied by the elevators and stairs. This

arrangement prevents the relatives and friends of patients sick with contagious diseases from coming in contact with these patients when they call for information, or for any other purpose that would necessitate their entering the department of administration. This also places all of the patients above the first floor, and consequently away from the dampness of the earth, and high

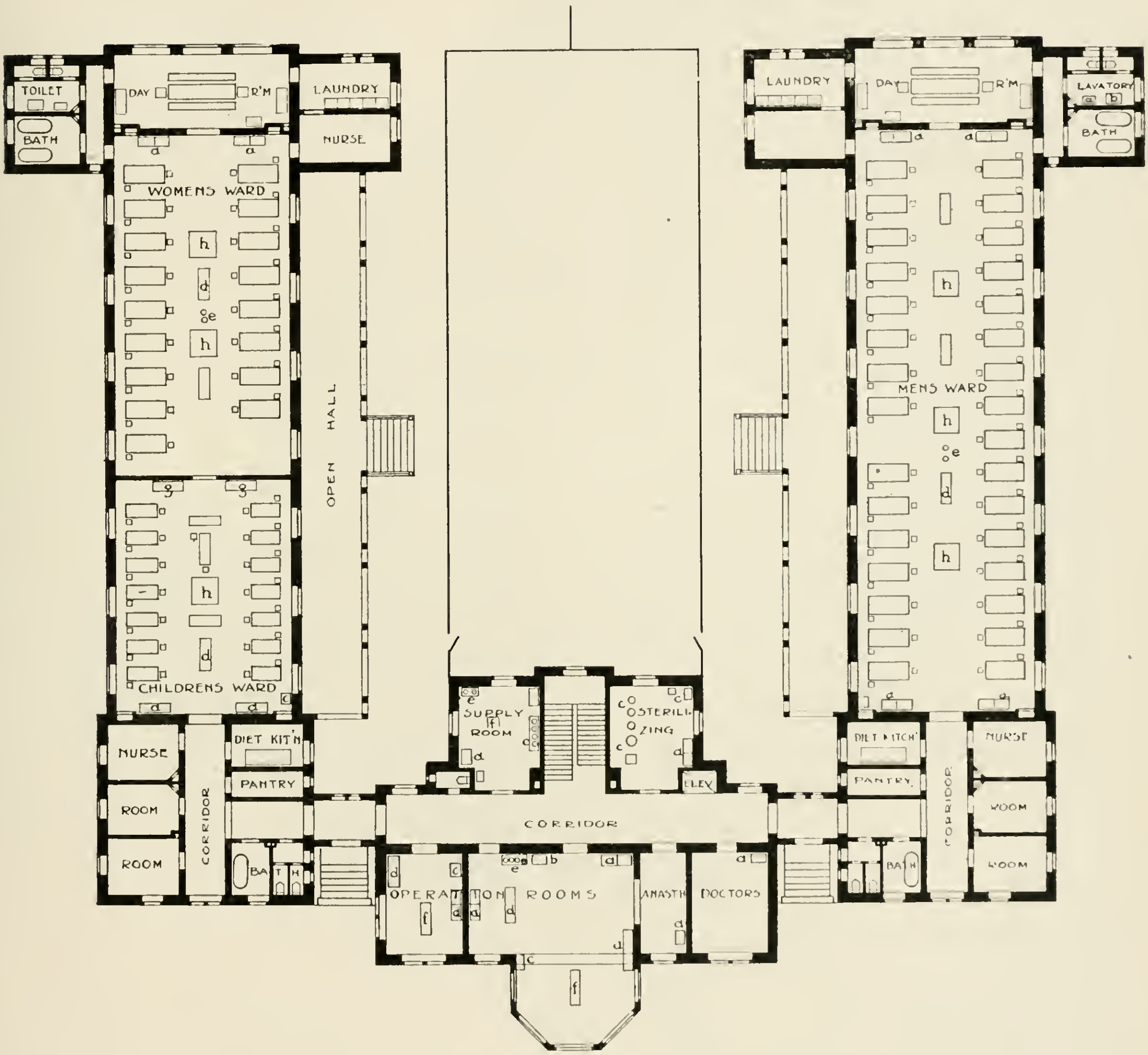


FIG. 309.

GENERAL HOSPITAL AT FRANKFORT, GERMANY, 1891. 75 BEDS.

A. Wash stand. B. Sink. C. Sterilizer. D. Instrument case. E. Bottle stand. F. Operating table. G. Wardrobe.

enough up to insure relatively good air. All the floors above the first may be constructed in a general way after the plan indicated in Figure 315. In a city sufficiently large to require an entire floor or pavilion for each disease, there should of course be built

FIG. 310.

RUDOLPH VIRCHOW CITY HOSPITAL, BERLIN, 1890. 1,627 BEDS.

1. Receiving building. 2. Administration building. 3. Nurses' building. 4, 18. Patients' buildings. 19. Bathhouse. 20. Operating building. 21. Gymnasium. 22. Chapel. 23. Mortuary. 24. Stable for animals for experiment. 25. Crematory for animals for experiment. 26. Disinfection building. 27. Pharmacy. 28. Porter's house. 29. Officers' residence. 30. Kitchen building. 31. Laundry building. 32. Boiler building. 33. Water tower. 34. Grading works. 35. Coal shed. 36 Repair shops. 37. Wagon sheds.

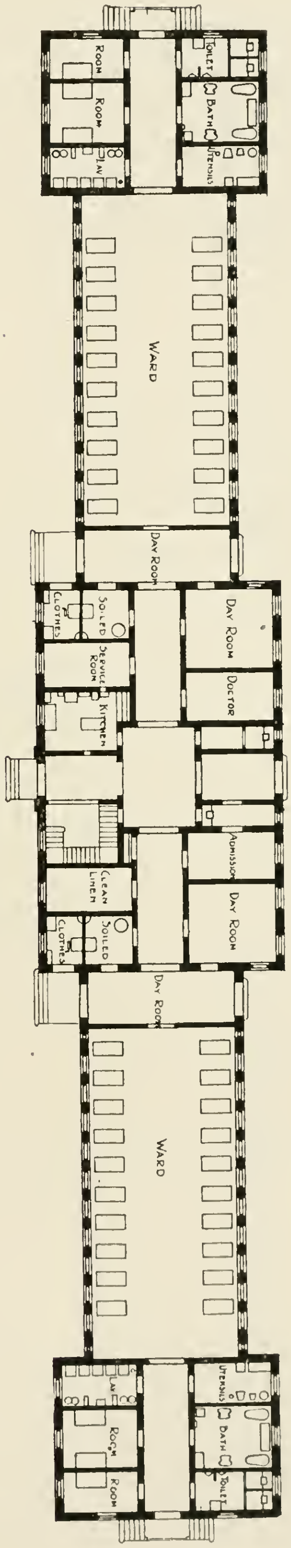


FIG. 311.

PAVILION OF RUDOLPH VIRCHOW HOSPITAL, BERLIN.

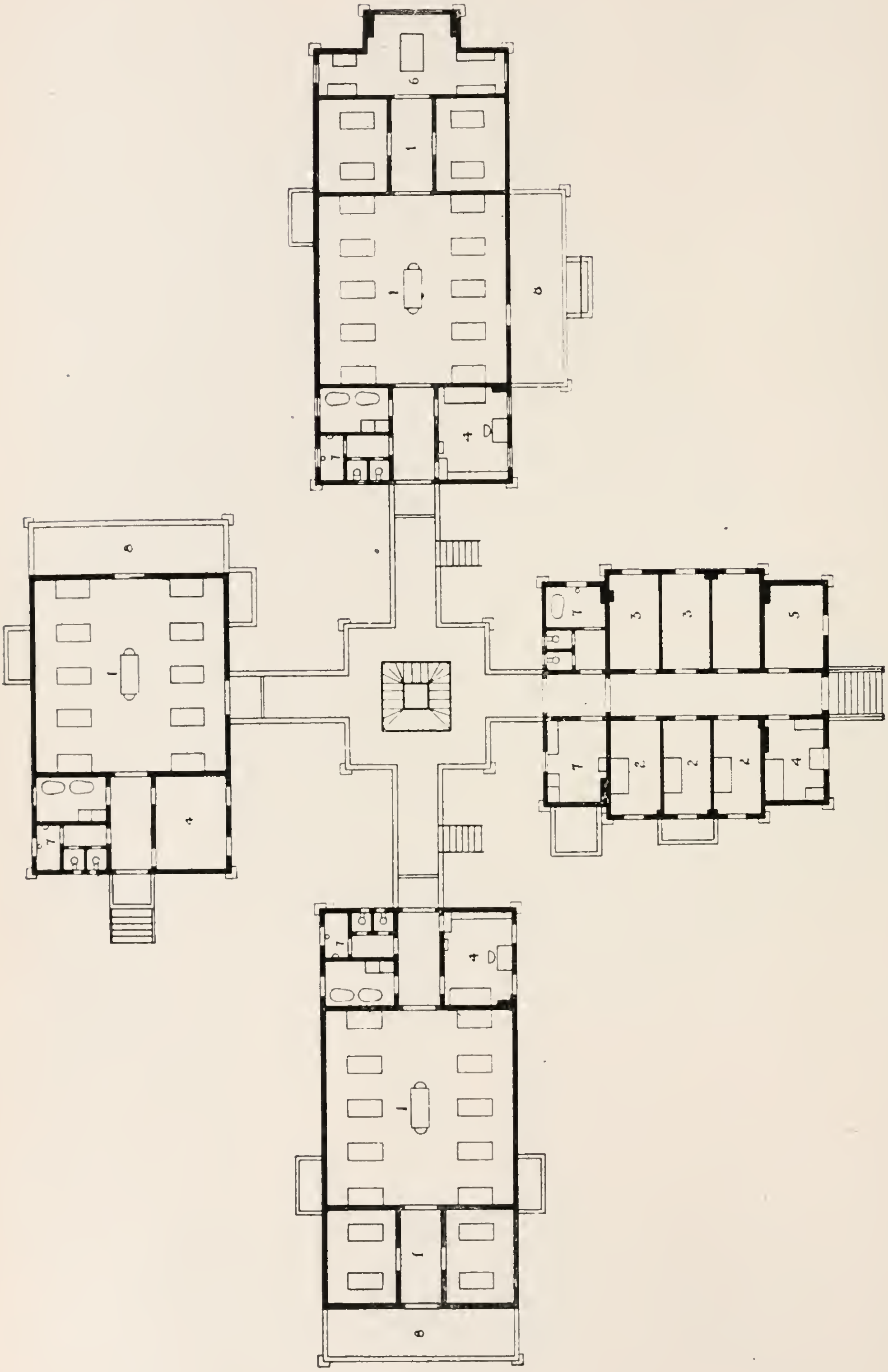


FIG. 312.

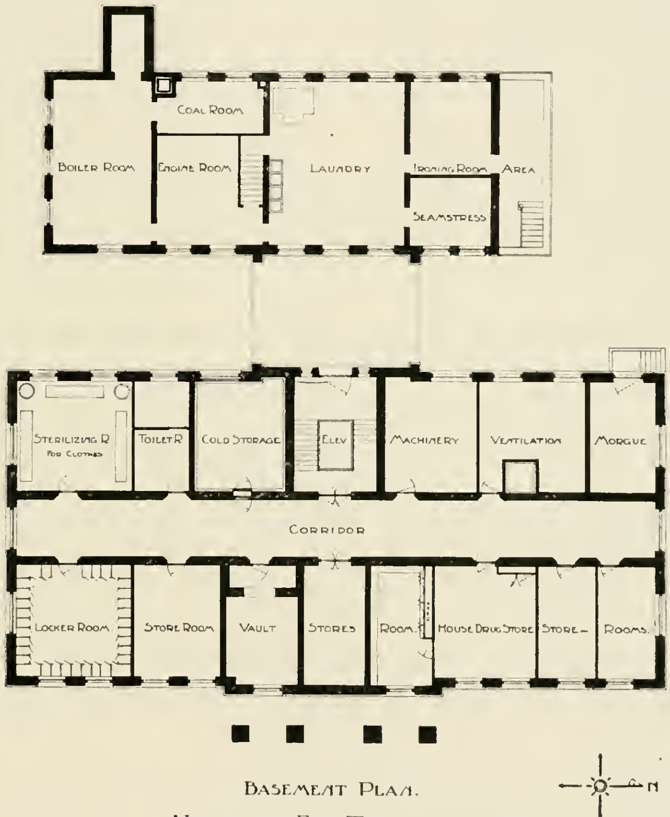
HOSPITAL FOR CONTAGIOUS DISEASES. 44 BEDS.

Charity Hospital, Berlin.

1. Ward. 2. Ward. 3. Play room. 4. Sisters. 5. Reception room. 6. Operating room. 7. Bath and store room. 8. Porch.

above the first floor as many pavilions or floors as there are prevalent contagious diseases. The diseases ordinarily provided for in these hospitals are diphtheria, scarlet fever, measles, whooping cough, erysipelas, and in some communities a pavilion is required for smallpox. This plan might also include several floors that could be placed at the disposal of patients in case of a large epidemic of any one of the contagious diseases.

On each floor of such a hospital there should be a single room in which patients could be placed for observation when there is



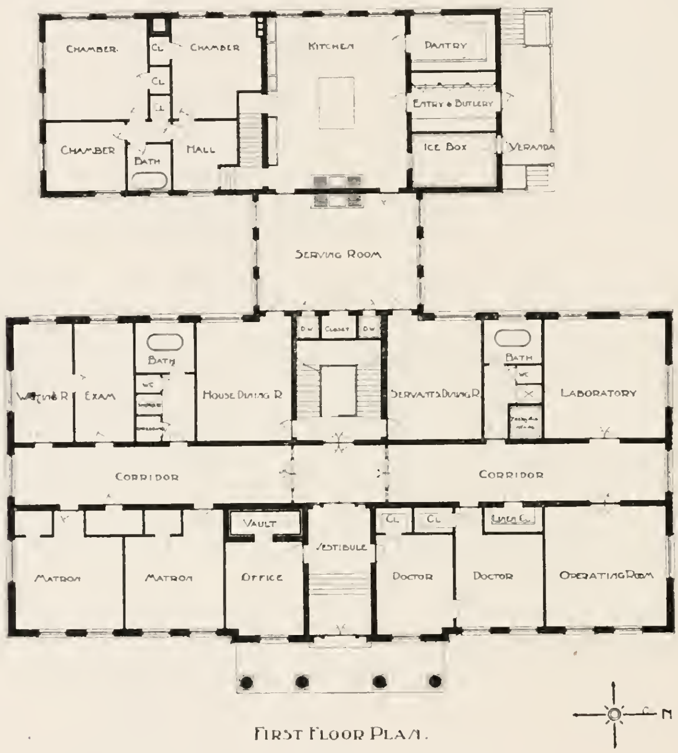
Basement Plan.
Hospital For Treatment
Of Contagious Diseases
Meyer J. Sturm, Architect.
FIG. 313.

doubt concerning the specific character of their disease, and the wards to which they should be assigned.

In plan 315 each ward could if necessary easily be changed into two smaller ones by the addition of a partition and the cutting of a second door into two private rooms. In fact, in the construction of such hospitals it would be wise to have several floors containing wards as shown in 315, which could be divided up into small wards, or into private rooms to be occupied by private pa-

tients suffering from contagious diseases. A further advantage in building a contagious hospital after this plan is to be able to not only enlarge it by adding more stories to increase the height, but it may be increased in length by adding to either or both ends. In most cities the original building is likely to be built too small, and with the increase in patronage an increase in the size of the building becomes necessary.

In a building which will ultimately require an entire floor for the treatment of one contagious disease, it will be well to build at least five stories, but to finish only the first story for adminis-



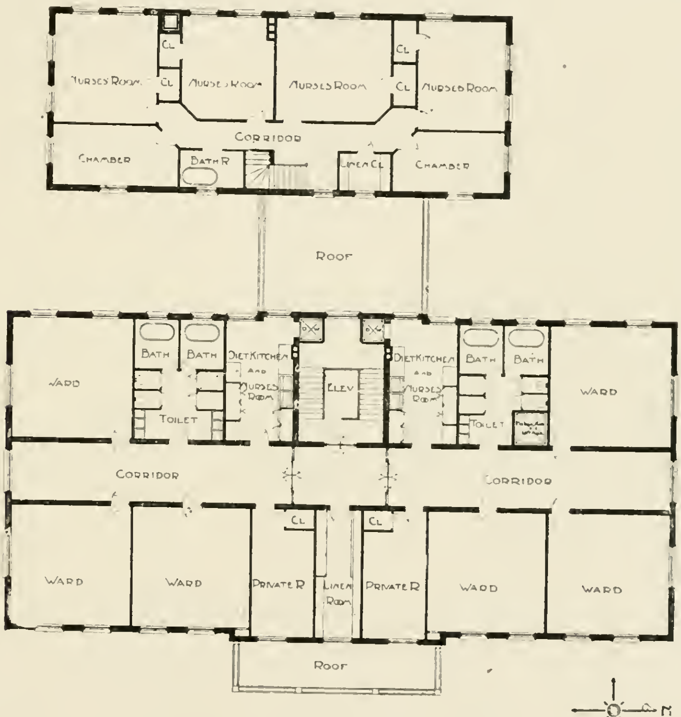
First Floor Plan.

Hospital For Treatment.
Of Contagious Diseases.
Meyer J. Sturm, Architect.
FIG. 314.

tration and the second and third stories according to the plan indicated in 315, where one pavilion or floor is made into two wards to accommodate two different diseases.

It will be seen that the dumb waiter opens into each one of the service rooms on successive floors, and it might be supposed that this would entail the danger of accidental infection, but, as has been pointed out before, all of the dishes and all of the linen that goes back to the floors is first sterilized. Another objection might be raised because of the fact that all patients, without regard to

their disease, are carried to their respective floors in the same elevator. It is an easy matter to prevent infection from this source. The patient is brought to the hospital on a stretcher, preferably in the form of a long, narrow basket. The patient is placed in this basket between two sterile sheets made of drilling seven feet long and six feet wide. These sheets are folded to cover the patient completely and when the ambulance arrives at the hospital the basket is placed upon the wheel stretcher, which is also covered with two sterile sheets, which are folded over both basket and patient, and not opened until the wheel stretcher stops at side of the patient's bed. After removing the patient from the stretcher



Second Floor Plan

Hospital For Treatment Of Contagious Diseases

Meyer J. Sturm, Architect.

FIG. 315.

the latter is enveloped in fresh sterile sheets, and the sheets that have been used around the patient are sterilized on the floor before sending them to the laundry.

In a contagious hospital more than in any other it is important that the nurses have a separate building for a nurses' home, that they may get entirely away from their patients after their day's work is finished.

RECENT HOSPITALS.

Figure 316 represents a plan which has been employed quite extensively during the last two decades. The space between the elevator, toilet, bath and service rooms being utilized as a diet kitchen, connected with the general kitchen by means of a dumb waiter. This form of construction was selected because of the desire to have a south exposure for every room, and an east and west exposure for the hall. In this case one-third of the floor space is occupied by the hall, one-half of the remaining space by the elevator, bath and service rooms, leaving only one-half of the entire space for the use of patients. It can be readily seen that this form of construction must be at least 50 per cent. more expensive than the form of construction described in Fig. 287. It is equally plain that the running expenses of such a hospital will be considerably greater.

By removing three of the partitions in this plan the six single rooms will be changed into three wards, each capable of accommodating four patients.

A single, many-storied pavilion constructed on this plan can, of course, be enlarged to any desirable size by adding to the length, or by additional stories. The disadvantages in this plan outweigh the advantages, and it is described here only with the view of preventing others from repeating the errors.

Figures 317, 318, 319 represent a hospital planned on the general principles represented in Figures 286 to 289, with the exception that this institution had to be constructed upon a triangular shaped piece of land.

Figure 317 represents the top floor, the north end marked "O" being used for operating rooms. Each one of these operating rooms has a very large north skylight, supplying an abundance of diffused light. On this floor also are all the other conveniences for the operating department, such as anesthetizing room, "M"; sterilizing room, "F"; room for storing sterilized supplies, "H"; general storeroom and service rooms, "S"; instrument room, "I"; X-ray room, "X"; recovery room, "A," and surgeon's dressing and locker room with shower and bath, "T." There are two rooms, "D," to which patients are taken for general dressings.

The recovery wards are of the greatest benefit to patients recently operated upon, as they are in charge of senior nurses and not removed to the general ward until they are in a condition not to disturb or be disturbed by the other patients. In this plan the recovery ward contains three beds, which seems sufficient for this hospital, which contains one hundred and fifty ward beds.

The recovery wards are used only for patients occupying ward beds. It might be well to provide a few single rooms on the operating room floor to be used as recovery rooms for patients

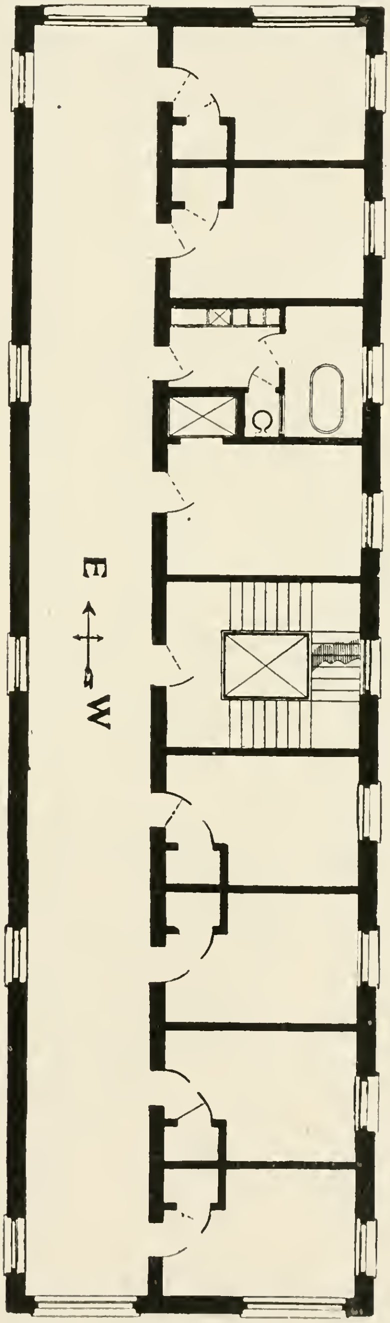


FIG. 316.

occupying private rooms. The entire operating department is isolated from the rest of the hospital, which adds much to the

comfort of the patients and relieves the hospital of much confusion.

This plan also gives an ideal operating department. It is located nearly one hundred feet from the ground, where the air

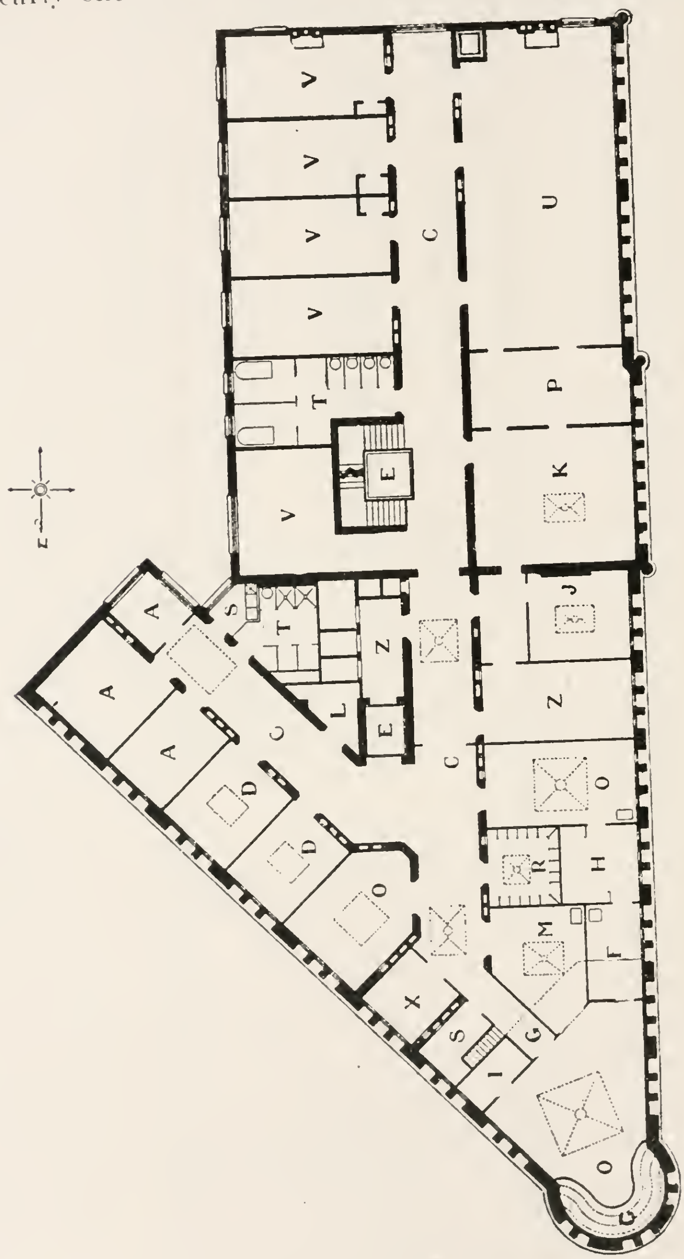


FIG. 317.

Augustana Hospital. Plan of Sixth Floor. L. G. Hallberg, Meyer J. Sturm, Architects.

is comparatively free from street dust. It is isolated from the rest of the hospital and is complete with all the conveniences, at an exceedingly small expense, the entire cost of the department

being less than \$15,000. Had the same conveniences been secured by the construction of a separate operating pavilion, the cost would have been three or four times this amount. This depart-

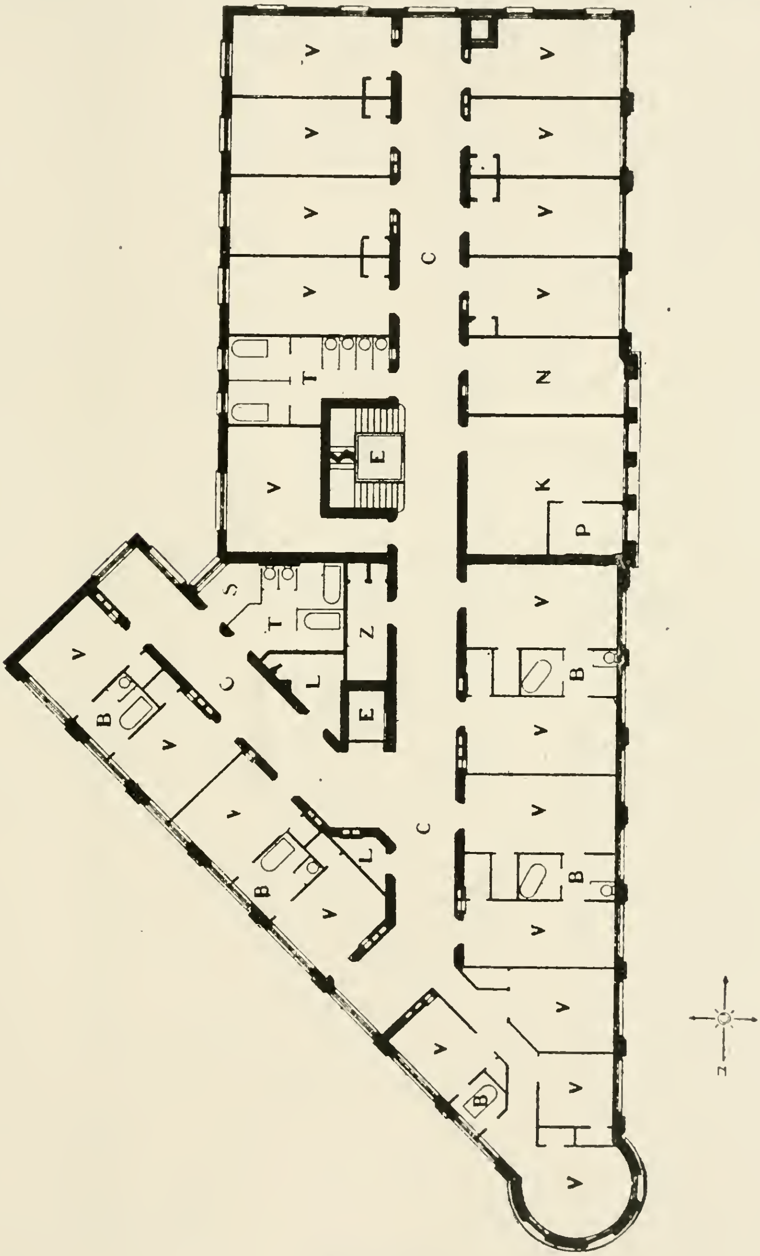


FIG. 318.
L. G. Hallberg, Meyer J. Sturm, Architects.

ment is sufficiently large for a hospital of 300 surgical beds. Were all of them ward beds, however, it would be necessary to have two or three additional three-bed recovery wards.

The west half of the south end of this floor is occupied by

the kitchen "K," the room for kitchen stores "Z," the baking room "J," the pantry "P," and the dining room "U." At c there is a door separating the kitchen department and the dining

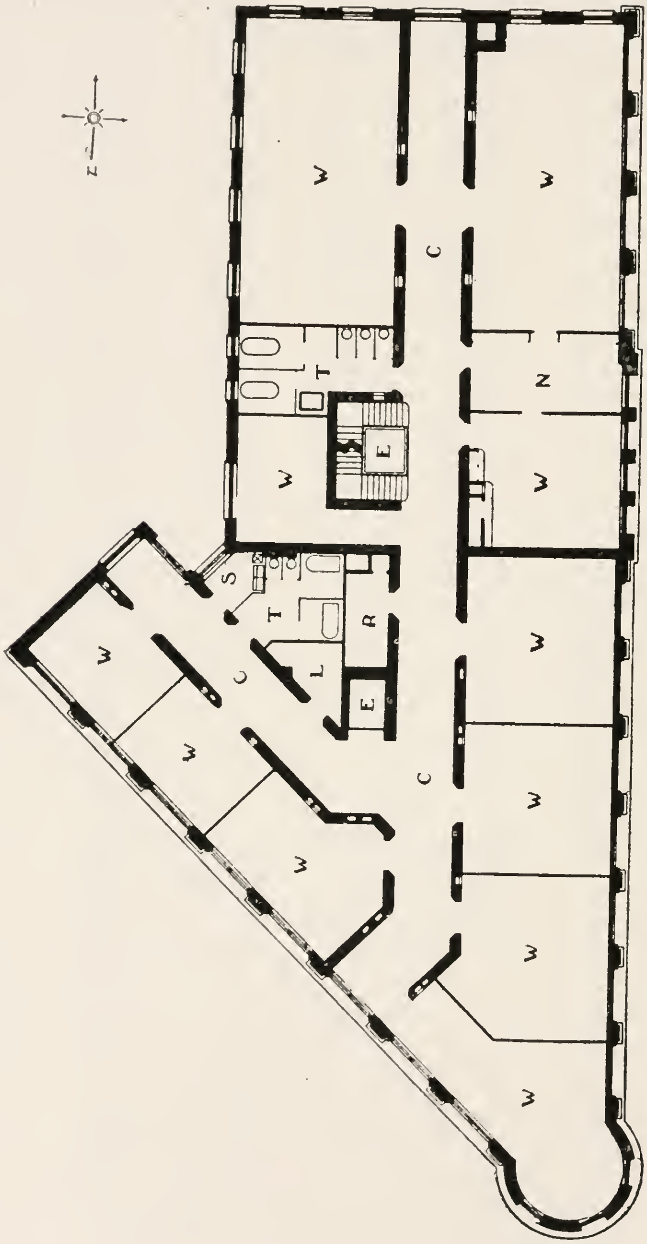


FIG. 319.
L. G. Hallberg, Meyer J. Sturm, Architects.

rooms from the surgical department. The dining room has been divided into two rooms, one for servants and the other for nurses and resident physicians. The east half of the west end of the building is occupied by the obstetrical department.

The two elevators "E" are badly placed. They should have been placed as indicated in Figs. 286, 287, 288, 289.

The room marked "V" just south of the elevator has been changed into a special diet kitchen, and notwithstanding its faulty position has been of great benefit and convenience to the institution.

At this point it may be well to again direct attention to the possibility of arranging the top floor in this plan in any way desired without regard to the arrangement of the outside walls, because perfect lighting and ventilation can be secured by the proper placing of skylights and flues. (See plans for model kitchen and operating departments.) With the proper placing of ventilating flues the odors from cooking and from the anesthetics in the operating rooms can be absolutely removed from the building. This arrangement has been tried and found to be perfectly satisfactory.

Figure 318 represents the fourth and fifth floors of this same building. They contain twenty-two private rooms, eight of them with private baths, and four others forming a suite with a private bath. The floor plan also contains two general baths and toilet rooms "T." There are two storerooms "L" and "Z," and a diet kitchen "K." The service rooms are separated by a six-foot partition. A dumb waiter in the northeast corner of the diet kitchen runs to the kitchen on the top floor, but this is not shown in Figure 318. This arrangement fills all the requirements of a first-class hospital.

It is very important in this class of hospitals to have all the floors so arranged that each individual floor contains only private rooms or only wards, because the mixing of private rooms and wards on the same floors has invariably given rise to endless annoyance.

Figure 319 represents the second and third floors of the same hospital. These floors are occupied entirely by wards containing 3, 4, 5, 6, 7, 8 and 16 beds. Experience has shown that wards with four beds are more satisfactory than any others. It is possible with wards of this size to place patients together so that they are congenial. It is possible to place those who are very ill or very recently operated in the same ward, which will prevent annoyance to others less ill. Moreover, the additional attention that must be given to these patients will not cause others less ill to become jealous because they do not receive the special attention given those who are more needful therof. A nurse can care for one of these wards if the patients are quite ill. If they are extremely ill she may be given a junior nurse as an assistant. If the pa-

tients are all convalescent she may care for two of these wards, either alone or with the aid of an assistant. In every instance each nurse will take an especial pride in her ward and there will be developed a wholesome rivalry between the nurses in charge of the various wards, a condition which cannot be obtained beneficially if patients are placed in large wards. The large wards at south end of this building, which were part of the old building constructed some years ago, would be much more valuable had they been divided into smaller wards. It seems that there can be no good reason for constructing a ward for more than eight beds.

Small wards are especially valuable in hospitals connected with medical schools, because one or more of these wards can be regularly assigned to a senior and a junior student for a definite period of time. In this manner the student has an opportunity to observe a definite number of patients from the time they enter the ward until they are discharged. In this way conditions are established between the student and the patient similar to those that exist between the physician and his patient in private practice, which makes the bedside work of the student really valuable, at the same time the patient's comfort is not disturbed and as he is under the direct care of a member of the faculty, the patient, the student and the hospital are simultaneously benefited.

Even in state, county or city hospitals it seems wise that in the future wards should be built for not more than eight beds. All of these hospitals should be utilized for teaching purposes and the small ward will aid materially in making profitable scientific bedside teaching in these institutions.

One of the floors in 319 is occupied entirely by male patients and the other by females. With elevators placed as shown in this volume, these two floors would be completely isolated from each other and from the private floors, and also from the first floor, which in this instance is occupied by the general offices, the office of the general superintendent, that of the superintendent of nurses, the waiting room, the examining rooms, the library, the laboratory, the chapel and the rooms of the resident physicians and surgeons.

In this manner one can obtain the advantages of concentration which results in economy combined with excellence of service. At the same time it is possible to isolate the floors so thoroughly that each floor affords the comforts to the patient that he could obtain were he to be in an entirely separated building.

This subject has been treated so fully in order to impress those interested that this plan has been thoroughly tried out and found most satisfactory and because this plan applies to condi-

tions such as exist in most communities in this country in which the construction of hospitals is contemplated.

Figure 320 represents a form of construction which must in time become popular. If placed so that the open side of the "U" faces south, with the elevators, stairways, bath and toilet rooms, kitchen and operating rooms situated along the north wall, every hall, room and ward in the building occupied by patients will be exposed to the sunlight for a considerable portion of the day.

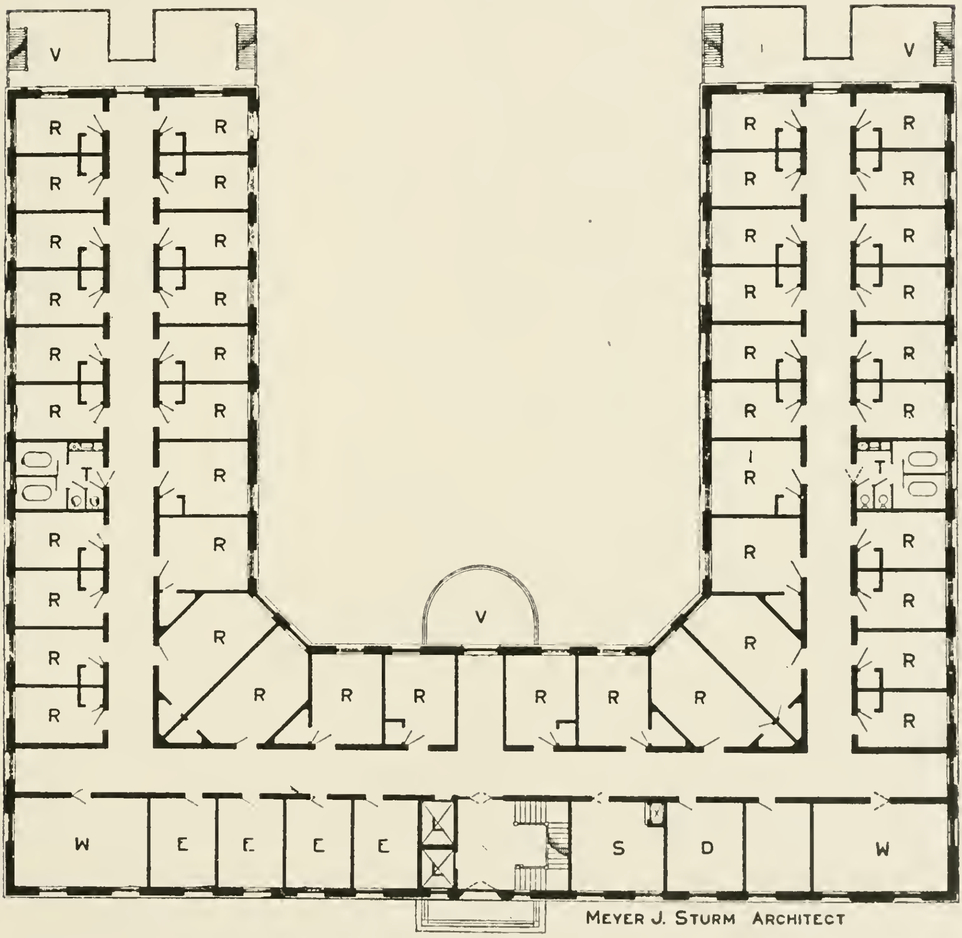


FIG. 320.

The main entrance can be placed in the court side of the cross building if south faces the principal street. Such a building can be easily ventilated and heated. The relative cost of construction is small for the amount of utility obtained. The size can, if desired, be increased by lengthening the parallel wings and by increasing the number of stories. It is, however, important that the height of the parallel wings does not exceed the distance between the wings, and that the length be less than twice the distance between the wings. Unless these precautions are heeded

shadows will be thrown which will interfere with the proper sunning of the windows directed toward the court. An explanation of this can be found in the section of Orientation of Hospitals.

In about the middle of each parallel wing should be placed toilet, bath and service rooms, in order to shorten the distances for nurses to walk while caring for their patients. Along the north wall may be placed treatment rooms for the various specialists, examining rooms, X-ray room. and the dark rooms to be occupied by eye patients.

One of the wings may be assigned to men and the other to women, or one or more floors may be assigned to each sex. It may also be arranged to have each floor or each wing assigned to one member of the medical staff and placed under his entire control as though it were a separate hospital.

The hospital may be arranged in wards of any desired size, or in private rooms, and the private rooms may be provided with baths according to the conditions best suited for the institution in question. The possibilities for excellence and economy of conduct in this form of hospital construction is excelled only by the plan described in Figures 286 to 289.

Figures 321, 322, 323 represent a hospital constructed on the general plan of the one just described, except that the building is placed with the parallel wings extending from east to west, instead of from north to south. In this instance conditions of secondary importance determined the placing of the building in this position. It is doubtful if it is ever wise to so locate this form of a hospital, as the results are so much more satisfactory when the structure is placed in the opposite direction. In order to overcome the defects the following plan is offered: The parallel wings are made relatively short, thus exposing a very long eastern wall to the morning sun. The elevators, stairs and bathrooms are situated in the corners of the courts. In this manner there is but one room without sun in the south wing and four rooms without sun in the north wing. By transferring the elevators and stairs to the corners on each side, just east of the bath rooms, and the bath and toilet in the north wing to the space occupied by the two eastern rooms on the north side of the hall, four more sunny rooms could be secured. By placing a west window in each room at the west end of the two wings, there would be left but one room on the entire floor (Fig. 321) without sunlight.

In this plan the location of the diet kitchen "K" was determined by the location of the general kitchen, on the first floor of a separate building between the two parallel wings. The kitchen would be much more satisfactory if located on the top floor, where

the odor from the cooking would not penetrate to the rest of the building. While it is beautifully and conveniently planned, and while it would entail a considerable cost to transfer it to the top floor, yet this will undoubtedly be done sooner or later.

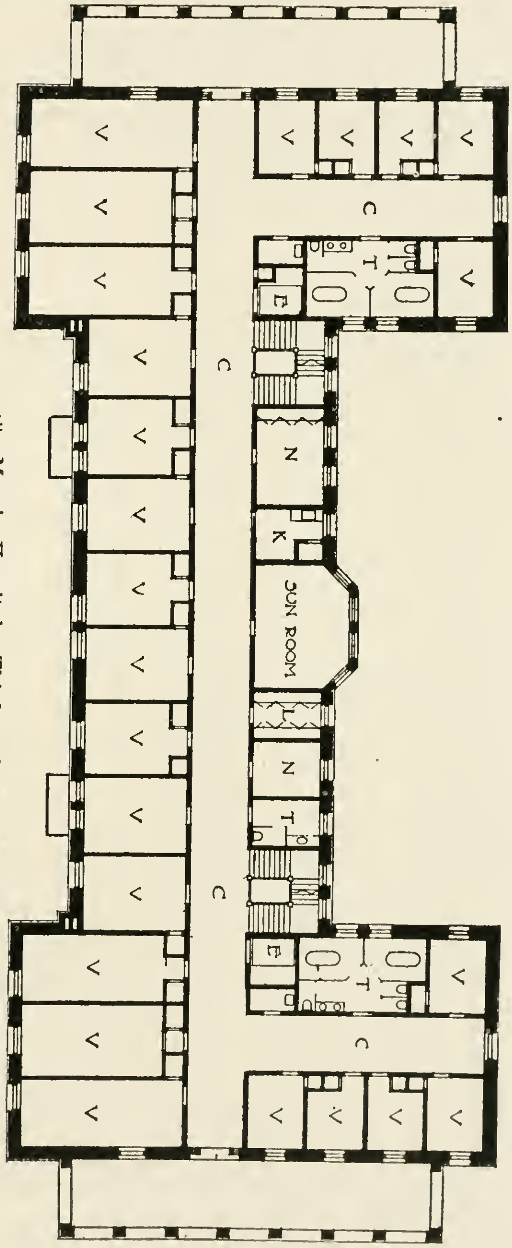
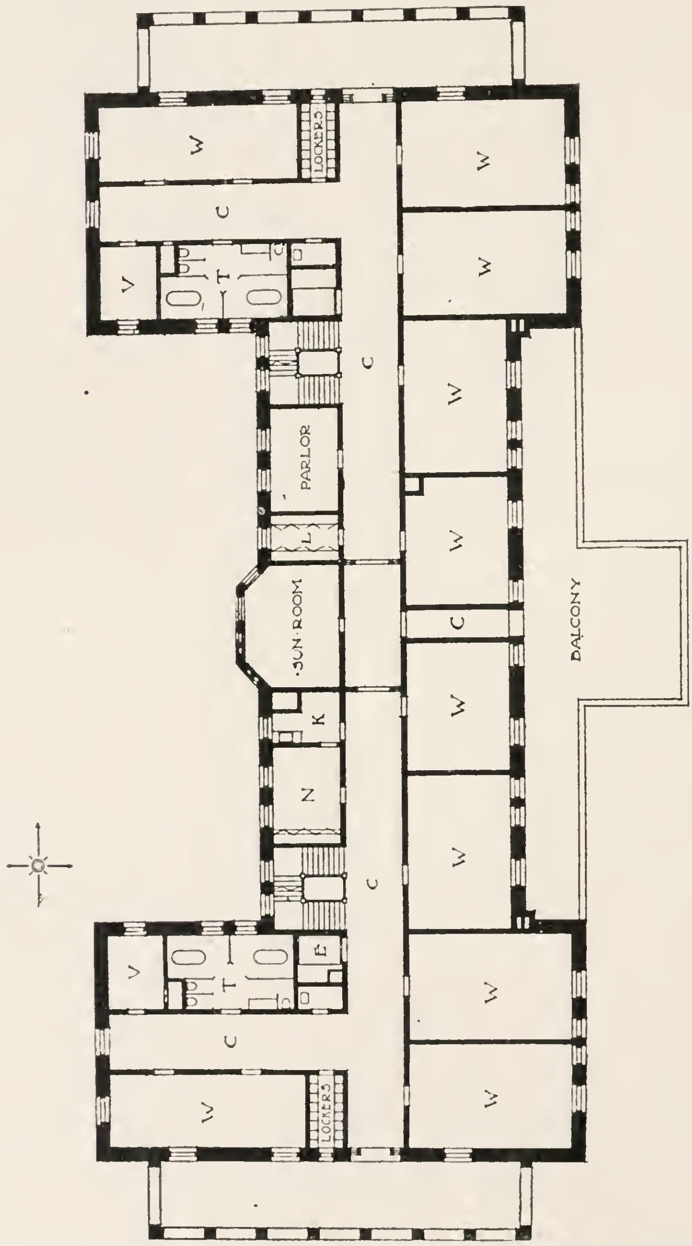


FIG. 321.—St. Mary's Hospital. Third and fourth floors.
St. Mary's Hospital, Chicago.
Henry J. Schlacks, Architect.

The windows were placed in the west walls of the wings, as the original plans provided for enlarging the building by lengthening the parallel wings to the west. This should be done by placing an outside court in the north wall on each wing, as shown in Figure 324. In this manner the hall will receive addi-

tional light, and four rooms which would otherwise be entirely without sun will receive east or west sunlight. By making this court sufficiently wide only one room is lost in each wing, and that is well paid for by the additional sunlight it will provide for the rooms in question.



St. Mary's Hospital. Second Floor Plan.
Henry J. Schlacks, Architect.

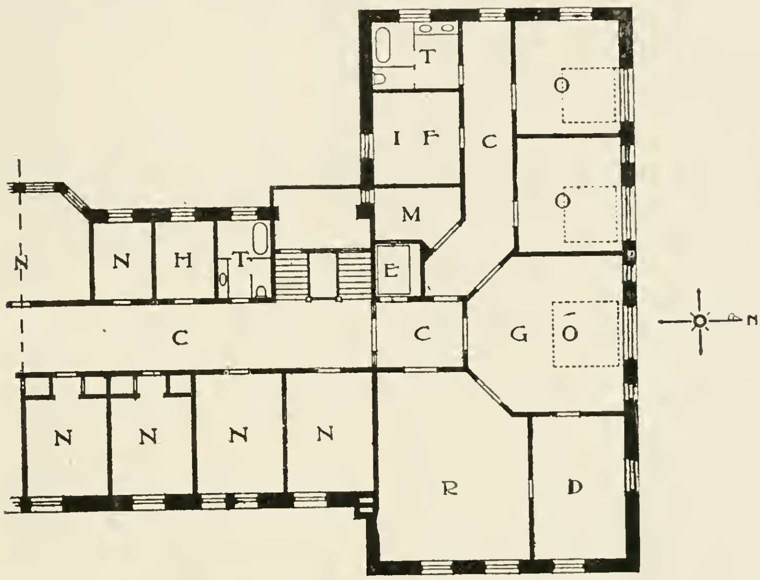
FIG. 322.

Figure 322 shows the ward floors in the same hospital. These wards contain from four to eight beds and every ward has sunlight. There is also an isolation room "V" in each wing, each one of which should have a west window, the one in the north wing

would later be closed when the building is enlarged, but this would not be important, as the room would still have a south window.

The lockers in which patients' clothing is kept after it has been cleaned and sterilized has been found a great convenience in this institution.

By placing a court in the north wall of each wing for every sixty feet added to the length of the wings, there will be but two



St. Mary's Hospital. Part of Fifth Floor.
Henry J. Schlacks, Architect.
FIG. 323.

rooms in each wing without sunlight and each ward on the north side of the halls will have both east and west sunlight if the entire space is left as a single ward. If it is divided into two smaller wards each one of these will have either east or west sun. All the rooms on the south side of this hall will, of course, have sunlight all day long. In case more than a hundred feet in length is added to each of these wings, it will be necessary to place another service room on the north side of each hall in order to reduce the work of the nurses. By following these suggestions the results obtained will be fairly satisfactory in case the enlargement of the hospital should be desired.

Figures 325, 326, 327, 328, 329, 330 represent a plan which must ultimately become popular for large municipal, state, county or city hospitals where it is especially desirable to have separate departments for male and female patients. As shown in Figure 331, this plan is provided with a central administration building with two parallel wings on either side for patients. These wings

extend from north to south. There is also provided in a separate building an out-patient department with an operating department in the second story which will serve for both wings.

It is well to locate the heating and power plant, the elevators

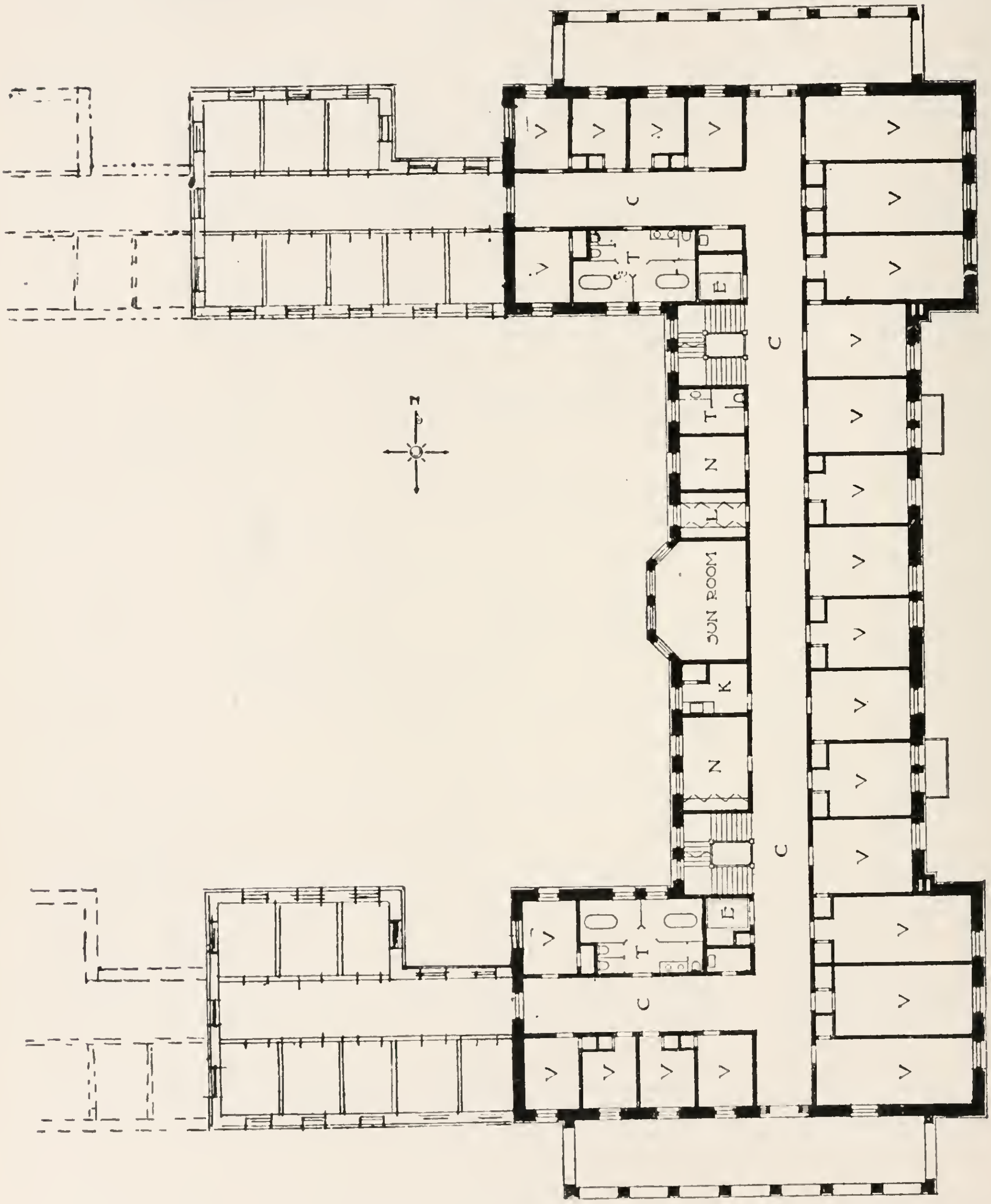
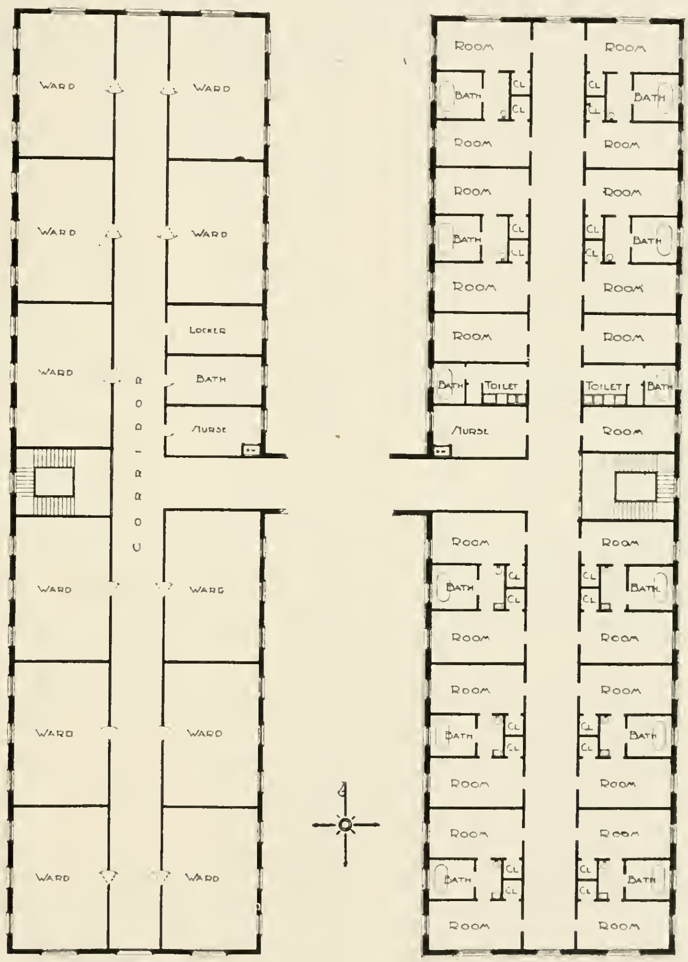


FIG. 324.

and dumb waiters, the morgue, laundry, ironing room and mending room in the first story of this building. The entrances to each of these departments can be so arranged that they will in no way interfere with each other.

The entrance to the out-patient department should be on the north side of the building, so that the patients coming to this department will not come in contact with the hospital patients proper. It is desirable that these two buildings have different street entrances, which will save the officials of both departments much confusion and trouble.



Ward Floor Plan Room Floor Plan

Building - B

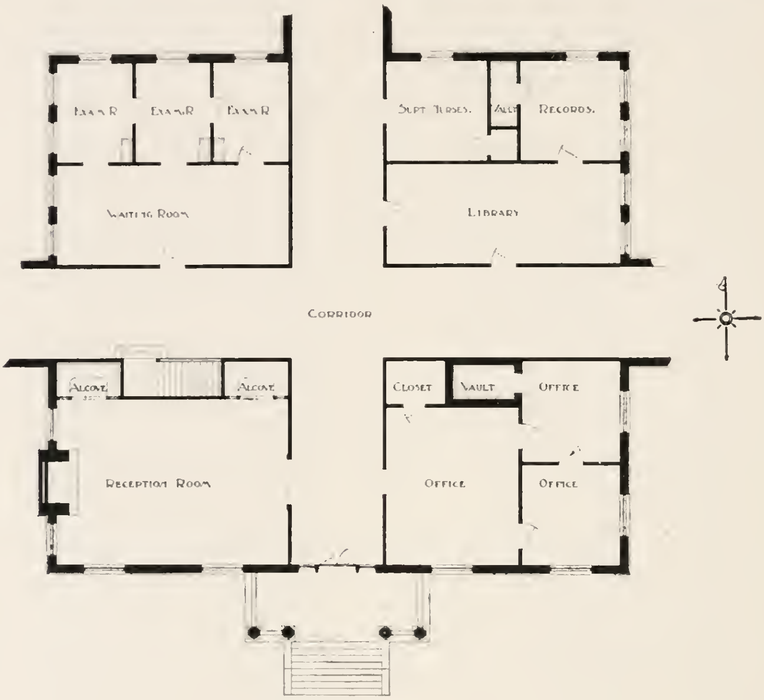
A City Hospital

FIG. 325. FIG. 326.

Meyer J. Sturm, Architect.

In case the hospital does not contain an out-patient department it is well to place the wards for patients suffering from contagious diseases in the second story, according to the plan already described. These wards would, of course, be reserved for patients developing contagious diseases in the hospital. In case patients suffering from contagious diseases are received for treatment in the institution, a separate pavilion should be built for the purpose.

It would be quite proper to have the boiler room, laundry, etc., in the first story, the out-patient department in the second story, the department for the treatment of contagious diseases developing in the hospital in the third story, and the operating and recovery rooms in the fourth story. This would necessitate building the administration building three stories high and the



First Floor Plan
Building - A
A City Hospital

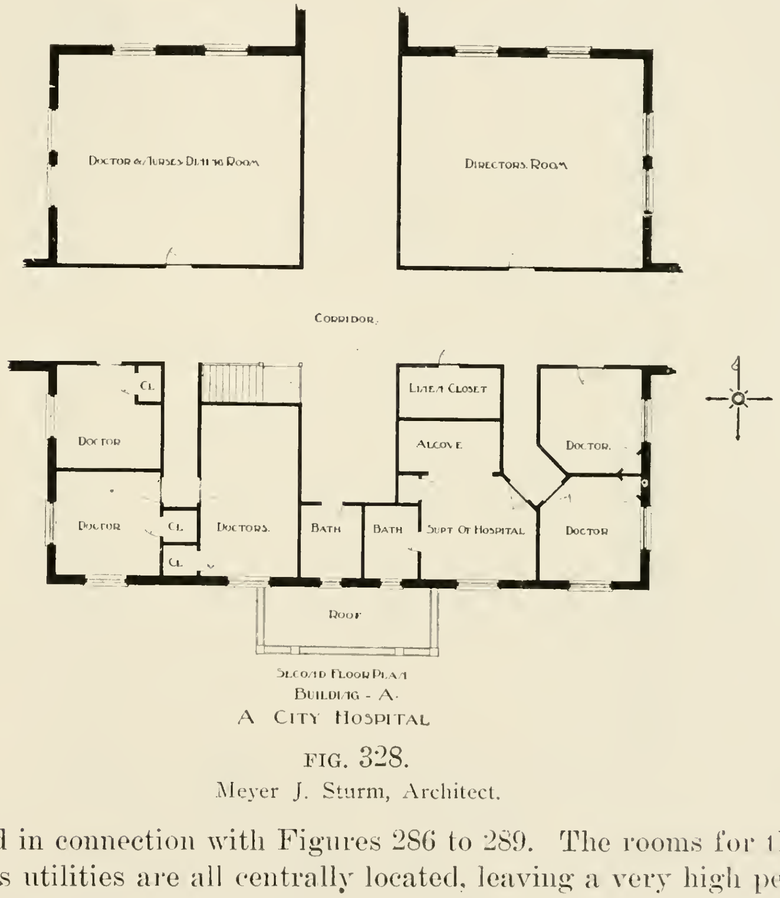
FIG. 327.
Meyer J. Sturm, Architect.

roof of this building should be connected by a bridge to the parallel wings, and also to the story containing the operating department. It is important in this plan to have high basements under the parallel wings, as patients will be housed on the first floors and they will in this way be farther removed from the unhygienic conditions which come from close proximity to the ground.

Another arrangement which is entirely proper in connection with this general plan is to place operating and recovery rooms at the north end of each of the parallel pavilions (Figs. 325, 326), thus providing a separate operating department for the male and female divisions of the house. This plan provides still another advantage which is important in the organization of municipal hospitals in growing communities. One parallel wing may first be constructed and the floors divided between the male and female

patients. Later when conditions demand accommodation for a larger number of patients, the second pavilion may be constructed and the sexes separated in the two pavilions.

Figure 325 represents the entire floor divided into wards which may be arranged in sizes to suit the conditions. According to this plan each ward has either morning or afternoon sun and the hall is exposed to sunlight at midday. The elevators and stairs are so placed that each floor is entirely separated from every other floor, establishing conditions corresponding to those de-



Second Floor Plan
Building - A.
A City Hospital

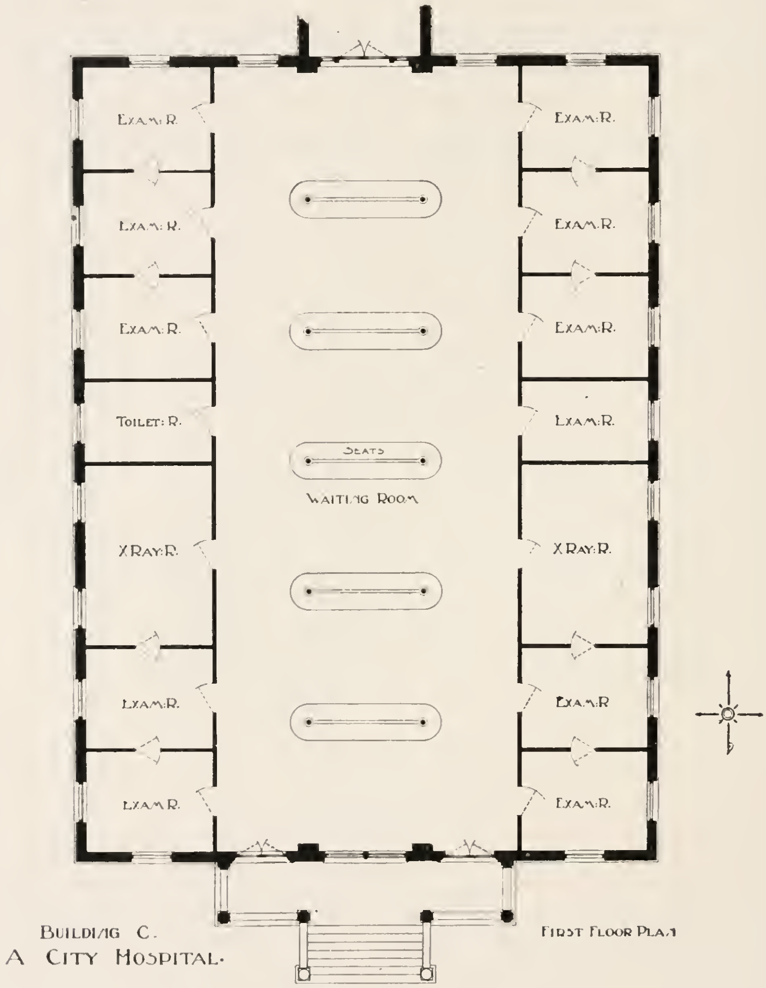
FIG. 328.
Meyer J. Sturm, Architect.

scribed in connection with Figures 286 to 289. The rooms for the various utilities are all centrally located, leaving a very high percentage of space for housing patients. Should one or more private rooms be required, either with or without private bath, this can be readily accomplished as shown in Figure 326.

The details of the administration building must necessarily vary with the particular requirements, and therefore no exact form can be given. Figs. 327, 328 show an arrangement for such a building.

Figure 329 represents the out-patient department for a large municipal hospital, the main feature being a large central wait-

ing room supplied with comfortable, stationary benches. The entrance to this waiting room is in no way connected with the hospital, but at the opposite end of this room are swinging doors which lead into a hall connecting this building with the administration department of the general hospital. These doors could be kept locked if complete isolation of the department was neces-



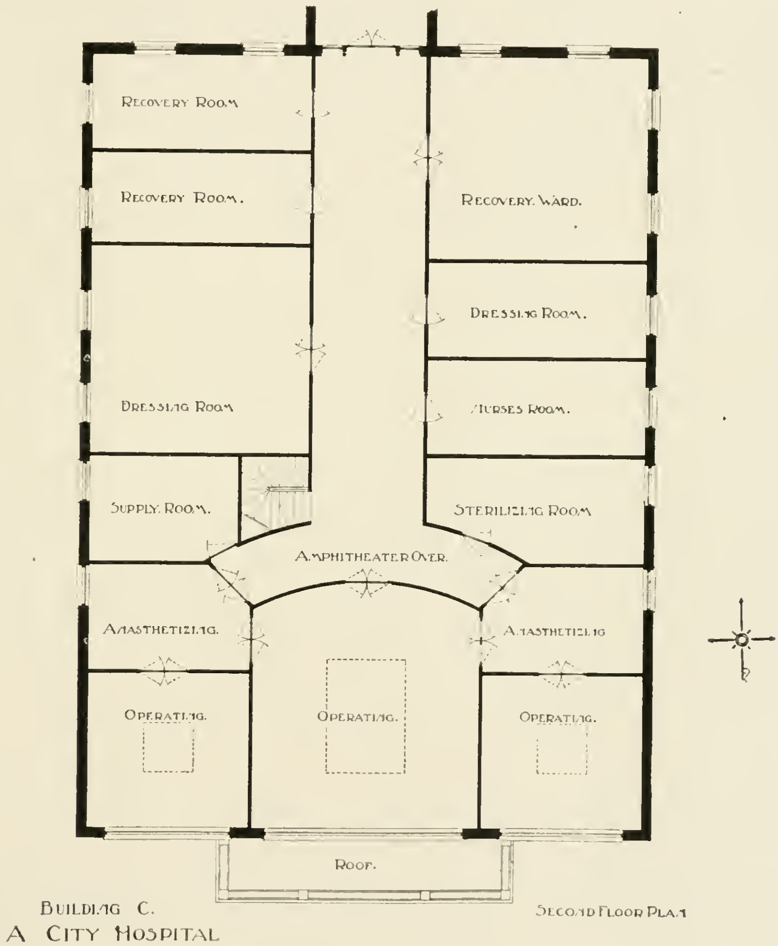
Meyer J. Sturm, Architect.
FIG. 329.

sary. This plan provides a large number of examining rooms. At the northern extremity of the building there should be rooms equipped for operating and dressing rooms to be used for the treatment of minor surgical cases. The different specialties will, of course, require particular conveniences in the various examining rooms, but these are details which must be provided for in individual plans. There should be a sterilizing room, a patho-

logical laboratory, and in most institutions a drug room. Each room should have hot and cold water.

The sketches presented here are intended to serve only by way of general outline; the plans for each department would necessarily vary with varying conditions.

Figure 330 represents the operating rooms, anesthetizing, dressing, supply and recovery rooms, also a service room for the nurses in charge of this department.



Meyer J. Sturm, Architect.

FIG. 330.

Provision is also made for an amphitheatre for the use of students in connection with the large central operating room that extends over the anesthetizing rooms and further over the two small operating rooms on either side of the large central operating room.

The anesthetizing rooms are located so that they can be utilized for either the small or the large operating rooms. It would

be well to use them also for dressing rooms. In that case the room marked as dressing room could serve as a further recovery ward, which would materially increase the working capacity of the department.

The small dressing room should be changed into a surgeons' dressing room with shower bath and toilet, and a number of private lockers.

This operating department is sufficient for a hospital containing up to four hundred surgical beds. The small recovery rooms

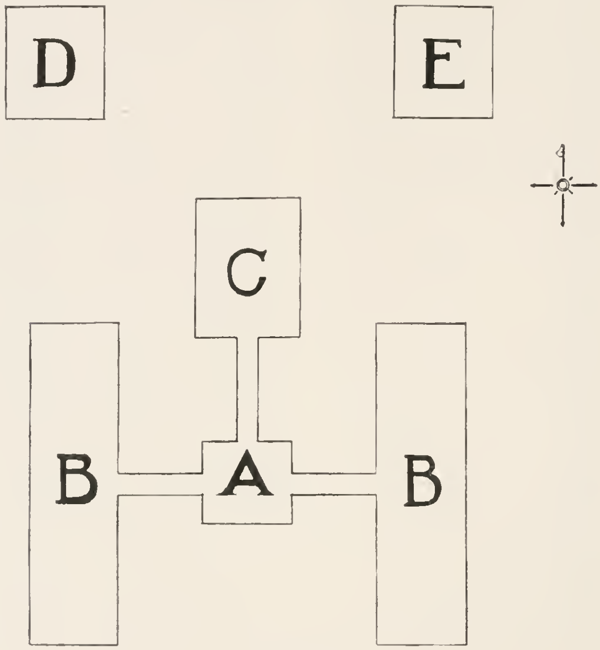


FIG. 331.

A. Figs. 327--328. B. Figs. 325-326. C. Figs. 328-329. D. Necropsy and Pathological Building, Morgue, etc. E. Nurses' Home.
Meyer J. Sturm, Architect.

will accommodate from two to three. the larger ones from four to six beds.

This arrangement isolates the operating department from the general hospital and thus does away with the annoyance of disagreeable odors due to the use of anesthetics and the noise of this department. Its conduct is somewhat more expensive than when located at the north end of the top floor of the pavilion containing the patients, but when constructed as the top story of a separate building, as in the plan at present under consideration, the expense of construction is but slightly greater than it would be were it placed as described in the previous plans.

HOSPITALS FOR CHILDREN.

Children are especially liable to contagious diseases, partly because they have not the wisdom to avoid those suffering from the infections and partly owing to the fact that adults who have them in charge are careless in their safeguarding. The fact that they do easily acquire contagious diseases from contact with other children furnishes an important element to be considered in the construction of hospitals for children.

A study of the history of epidemics in children's hospitals in this country and abroad shows definitely the danger of patients acquiring the contagious diseases while in hospitals under treatment for the relief of some other affection. The infections most commonly acquired are as follows: Gonorrhœal vaginitis, scarlet fever, diphtheria, whooping cough, chicken pox and pemphigus. To these might be added pneumonia, spinal meningitis and tuberculosis.

It has been found that three provisions of management are necessary for the prevention of infections, and three which have reference to construction.

The first provision refers to the examination which is made preceding the admission of the patient. If the responsibility of admitting patients is placed upon a single member of the staff, it but rarely happens that a patient suffering from a contagious disease is admitted into the hospital. In case of doubt the patient should be isolated until a positive diagnosis can be made.

The second source of danger comes from using different articles promiscuously among the children, and from the nurse going from one child to another without washing her hands.

The third danger comes from indiscriminately admitting visitors into the wards.

The errors in construction refer first to a lack of provision for isolation. In every suspicious case the utmost precaution should be taken to prevent the infection of other children. This can be accomplished only by absolute isolation, provision for which will be discussed in "typical" plan for children's hospital.

Figure 332 represents one floor of a children's hospital, the two halves being exact duplicates of each other, one intended for the care of boys, the other for girls. It has been found best to separate the sexes in caring for children more than ten years of age (some authorities insist upon the separation above the age of six).

One feature carried through the entire plan is swinging doors between each ward and the adjoining hall, with an additional pair

of swinging doors on either side of the hall immediately in front of the elevator. Children well enough to be up and about are much more likely to remain in their own departments if these are separated from the remaining portion of the hospital by doors that are kept constantly closed.

The building extends from north to south so that every room and every ward is exposed to the morning or afternoon sun during some portion of the day. The hospital can, of course, be enlarged to suit any demand for capacity by lengthening the building and by the addition of further stories.

Each wing contains three large wards, each with a capacity of eight beds, and two private rooms which could contain two beds, although they are intended for but one. There are also two isolation rooms with the same capacity. There are toilet, bath and service rooms and a separate dressing room and toilet for the use of the nurse. A diet kitchen is connected by dumb waiter with the general kitchen and the special diet kitchen, which are located on the top floor. This diet kitchen communicates with the general hall, and it communicates with the isolation rooms through a glazed door leading out upon a bridge, which in turn leads to a glazed door opening into the isolation rooms. Ordinarily it would not be necessary to use this bridge, as it is but rarely that such absolute isolation is required. When it is necessary, however, the double doors leading into the general hall from the isolation rooms are closed and the bridge alone used. All communication is carried on by telephone, the isolated nurse or nurses, if one is employed at night and one by day, occupy one of the rooms and the patient the other. One of the two little service rooms contains a toilet, and a steam and hot water combined sterilizing apparatus, the other contains a small gas or an electric stove. The physician enters the rooms after he has completed his visits to the other patients, and does not return to the wards after leaving this department. His clothing is protected by a sterile gown, his hands by rubber gloves, which are sterilized immediately he leaves them in the isolation rooms. All the linen used in this department is different from that of the other portion of the hospital, and everything returned to the hospital proper is first sterilized and then placed in a sterile bag.

Ordinarily one of these isolation departments will be sufficient for a floor containing fifty patients and the other isolation room may be used for children who are especially ill or noisy.

In case it seems best the entire floor may be served from one diet kitchen, the door leading from the other diet kitchen into the hall being closed and the room utilized in connection with the cor-

responding isolation rooms, the nurse being served directly from the general kitchen and from the special diet kitchen through the dumb waiter. In this case all the dishes should be sterilized in the general diet kitchen.

An important feature of these diet kitchens is a sterilizer in which all dishes, knives, forks and spoons are boiled before they are returned to the general kitchen. If preferred, they may be kept in a cupboard on each floor, but before being replaced everything should be sterilized.

Box Wards.—The box ward furnishes a means whereby a number of patients may be placed in a ward without danger of mutual infection, in case one of the patients should develop a contagious disease.

The simplest and least objectionable method of arranging a box ward consists in placing wire glass screens four feet in width and six feet long, mounted on nickel frames, which stand one foot from the floor, half way between two neighboring beds.

It is doubtful whether a sitting room as indicated in Figure 332 is an advantage in a children's hospital. The plan would require an additional person or nurse to watch the children in such sitting room, as they should not be left alone. It has been suggested that children who are severely ill be placed in one ward; those but slightly ill in another; and those able to be up and about in a third, thus making a comfortable arrangement and saving the services of an additional nurse.

One source of care and annoyance of officials in children's hospitals comes from the fact that mothers are so often determined to remain with their sick children. When it is impossible to convince a mother that the child's chances for recovery are better if it is left to the exclusive care of the nurse, the patient should then be given a private room. The mother should never be allowed to remain in the ward and thus demoralize the discipline of the hospital, and of the other children.

In every children's hospital of considerable size it is well to have a separate floor provided with private rooms with or without private baths. These floors should be arranged in a general way according to the plans described in Figure 288.

In Fig. 333 is shown a form of hospital built in 1880, in which more than half the area is utilized for administration. It is very expensive in construction, two stories in height, the second story being a repetition of the first story. It provides an abundance of sunlight, good ventilation, and a great deal of space for open air treatment on the verandas. The veranda would necessarily cut off considerable sunlight on the first floor, but probably not

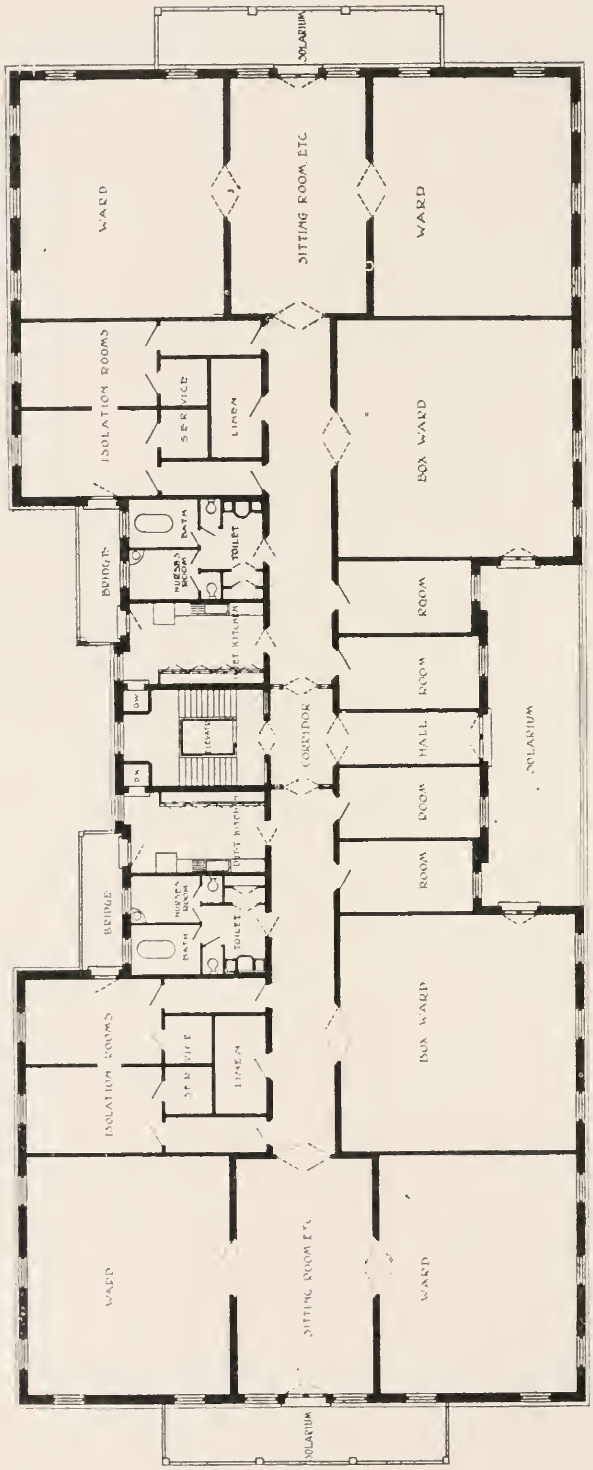


FIG. 332.

Plan for a Children's Hospital

Meyer J. Sturm, Architect.

enough to be objectionable on that account. As compared with Fig. 332 for the same amount of money expended, it will not ac-

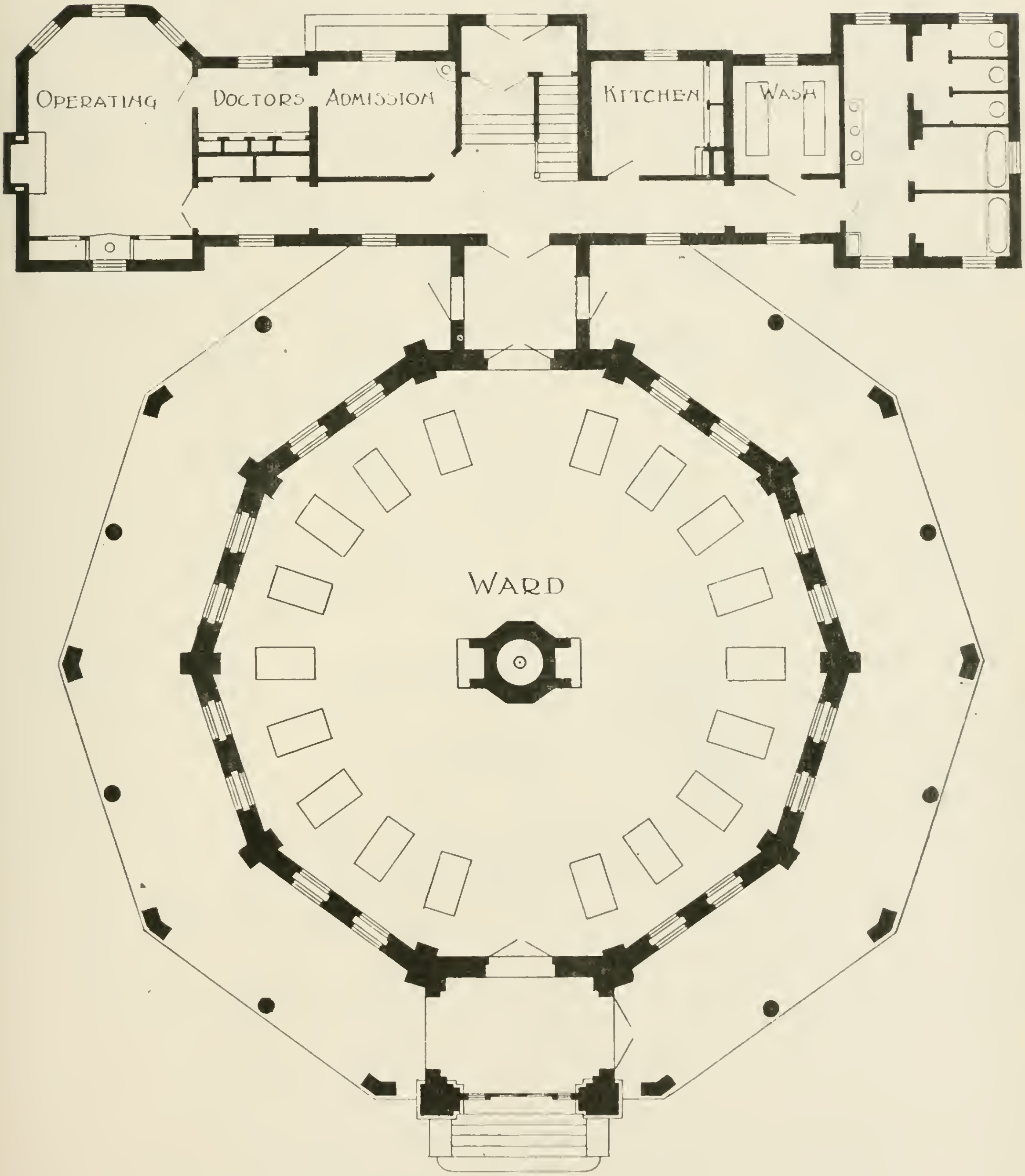


FIG. 333

commodate as many patients, nor is there the provision made for isolation, which is so necessary in children's hospitals.

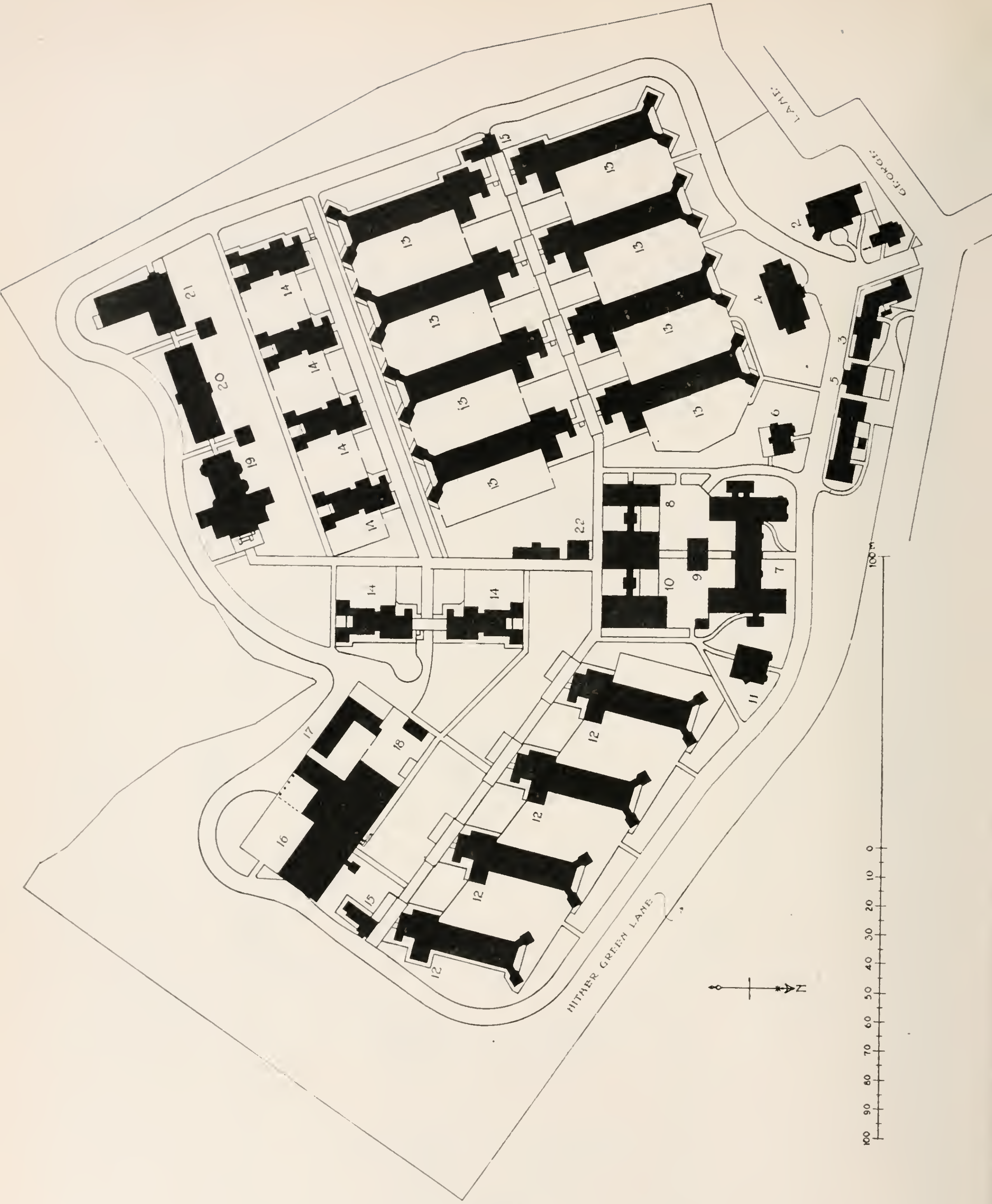
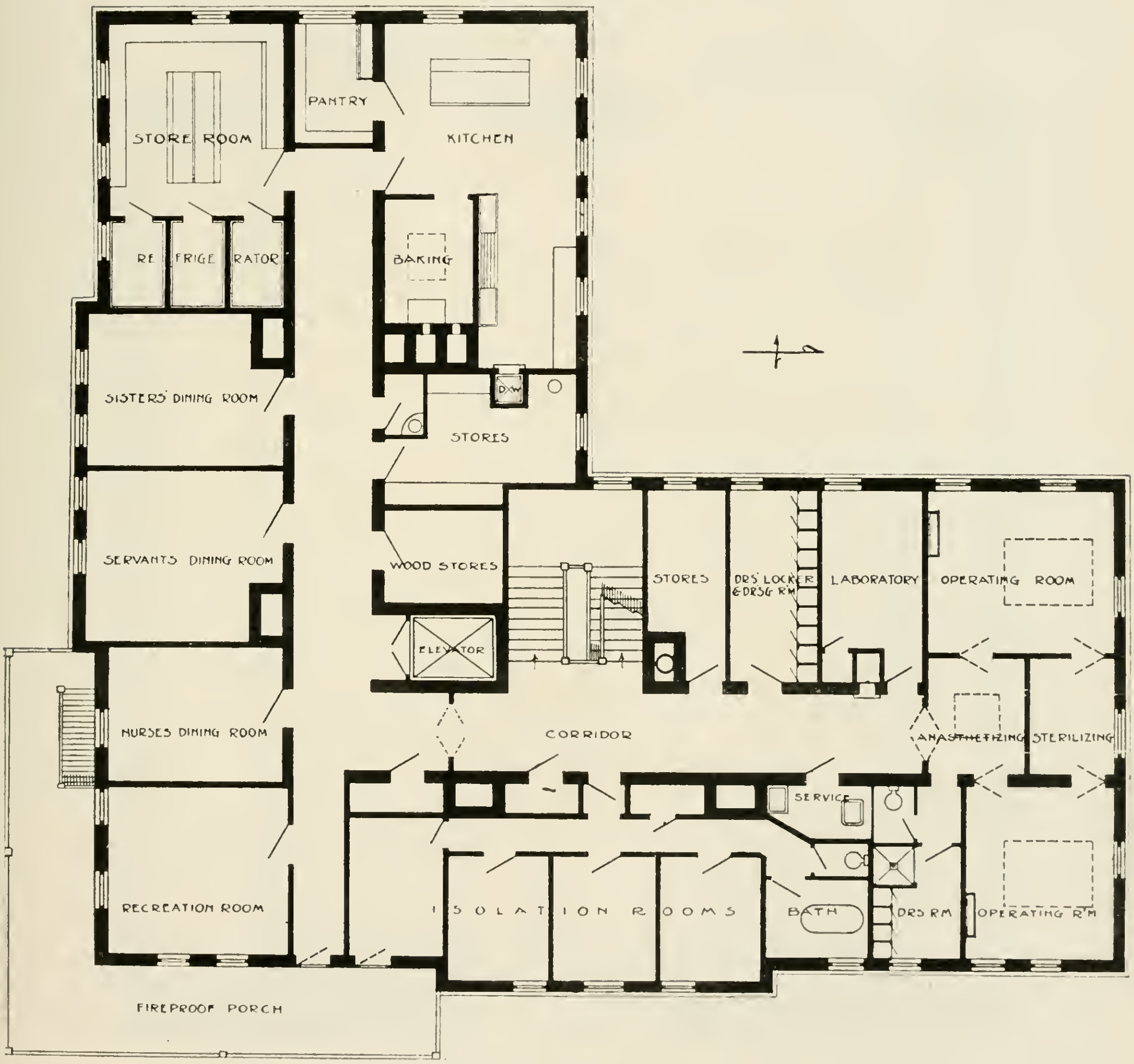


FIG. 334

1. Porter. 2. Physician-in-Chief. 3. Convalescent building. 4. Administration. 5. Morgue. 6. Steward. 7. Female employes. 8. Male employes. 9. Meat and fish storehouse. 10. Kitchen department. 11. Internes' department. 12, 14. Pavilions. 15. Receiving ward. 16. Laundry. 17. Work shop. 18. Disinfecting building. 19. Nurses' home. 20. Apprentices' home. 21. Night nurses. 22. Water tower.

Eight pavilions for scarlet fever, forty-six beds each, 368; four pavilions for diphtheria, thirty beds each, 120; six isolation pavilions, ten beds each, 60; total, 548.

Fig. 334 is an example of a pavilion hospital, which covers all available space to such an extent that there is very little parkway left. If the building marked 12 and 13 had been made into a ten-story hospital, and the service buildings had been placed at the rear of the grounds, this hospital would have been provided with large park space; or if the buildings marked 7-8-9 and 10 had been taken as the administration section of a U-shaped hospital of five



Meyer J. Sturm, Architect.

FIG. 335

stories, with half the patients in one wing and half in the other, with the administration between, as shown on the U-shaped plan in this book, the hospital would have been ideal. An arrangement such as shown in Fig. 331 would also have been superior to the

present arrangement. The wings and floors to be divided as shown in Figs. 313 to 315.

Fig. 335 shows an operating floor on the L shape. This hospital was built some years ago, four stories in height, with a high sloping roof and an attic, which was of no service whatever. In remodeling after the building had been partly destroyed by fire, the above plan was adopted for the fifth floor and a flat roof put on. In the room connected with the kitchen marked "stores" has been placed a diet kitchen, making the entire kitchen and dining

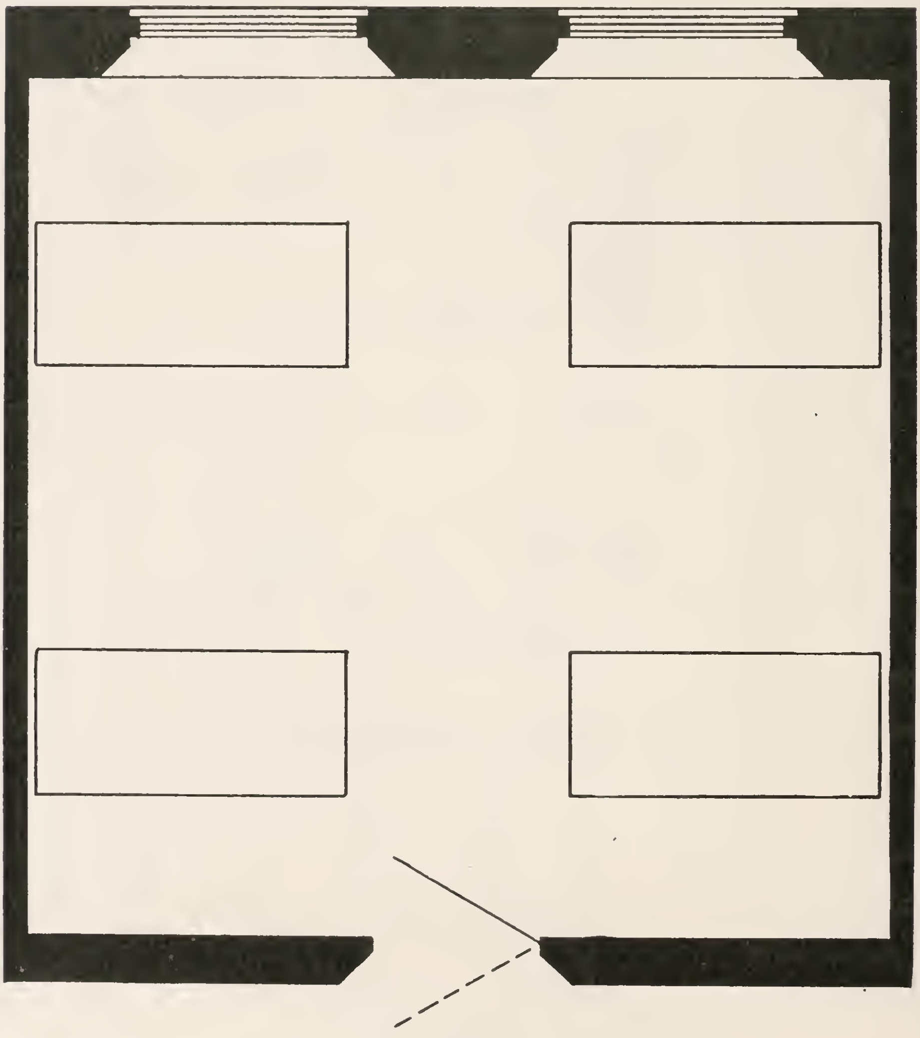


FIG. 336

room department isolated and practically perfect, the operating and isolation departments being divided from the remainder of the floor as shown. The kitchen was in the basement before remodeling took place.

Fig. 336 shows a typical four-bed ward.

Fig. 337 shows the general arrangement and equipment for a private room in a hospital.

Fig. 133 shows the general arrangement and equipment of a private room in a hospital connected with a private bath. As will be seen there are two rooms connected with each such bathroom, making it possible to use these rooms en suite, or one room with or without bathroom.

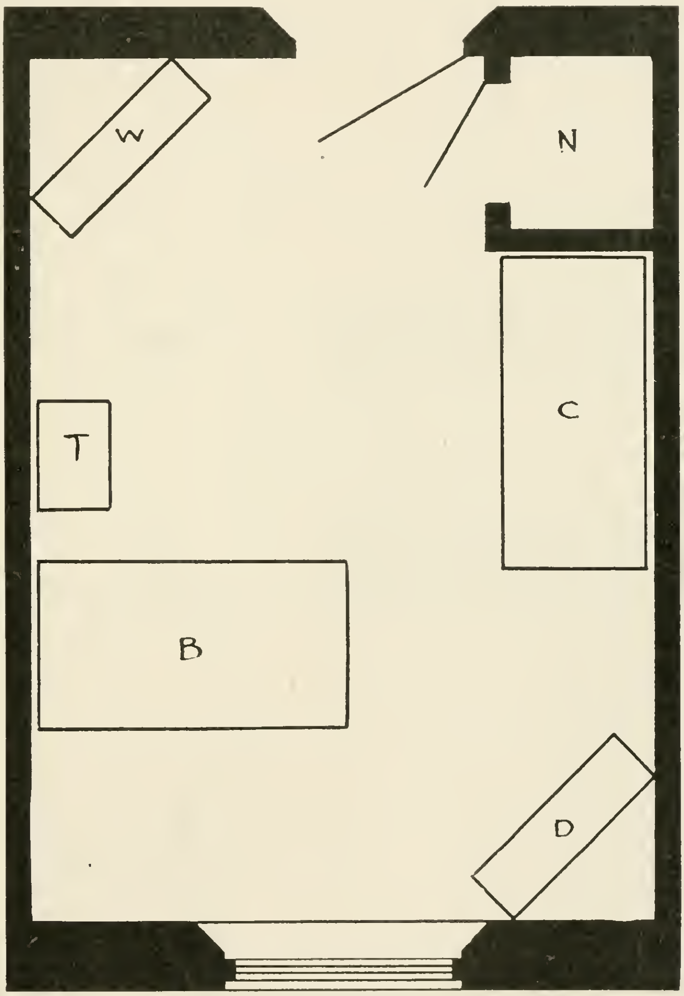
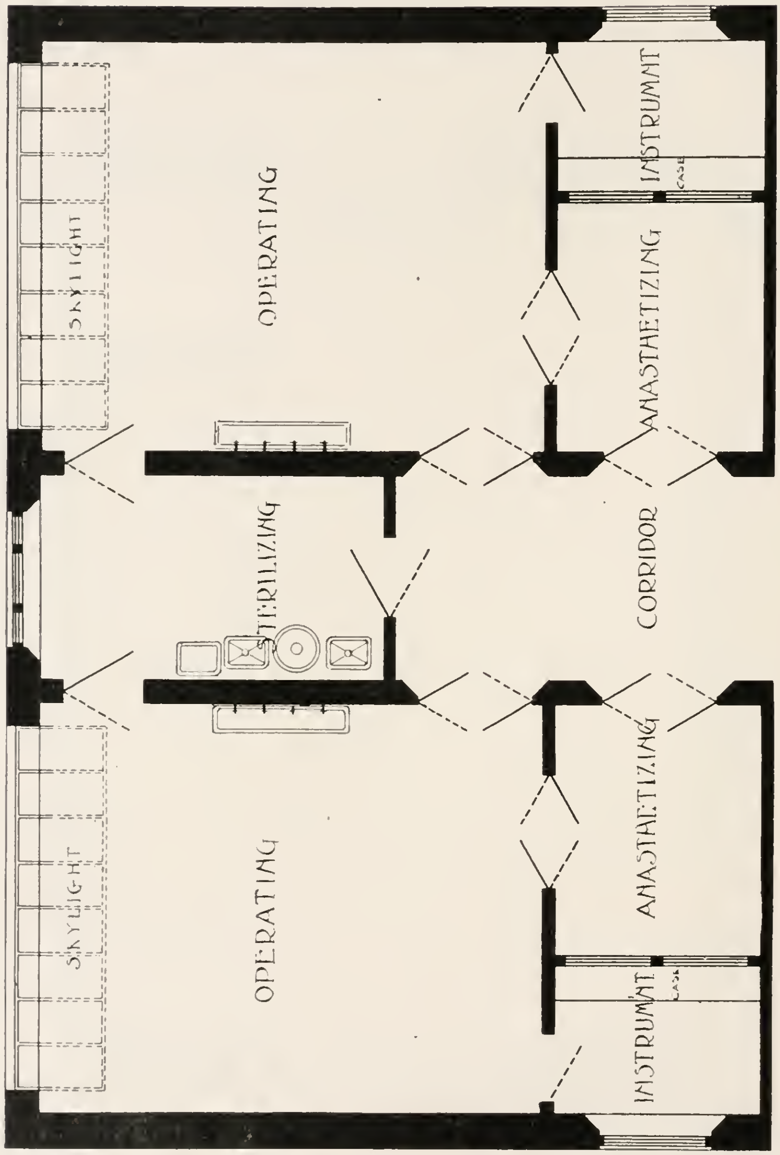


FIG. 337

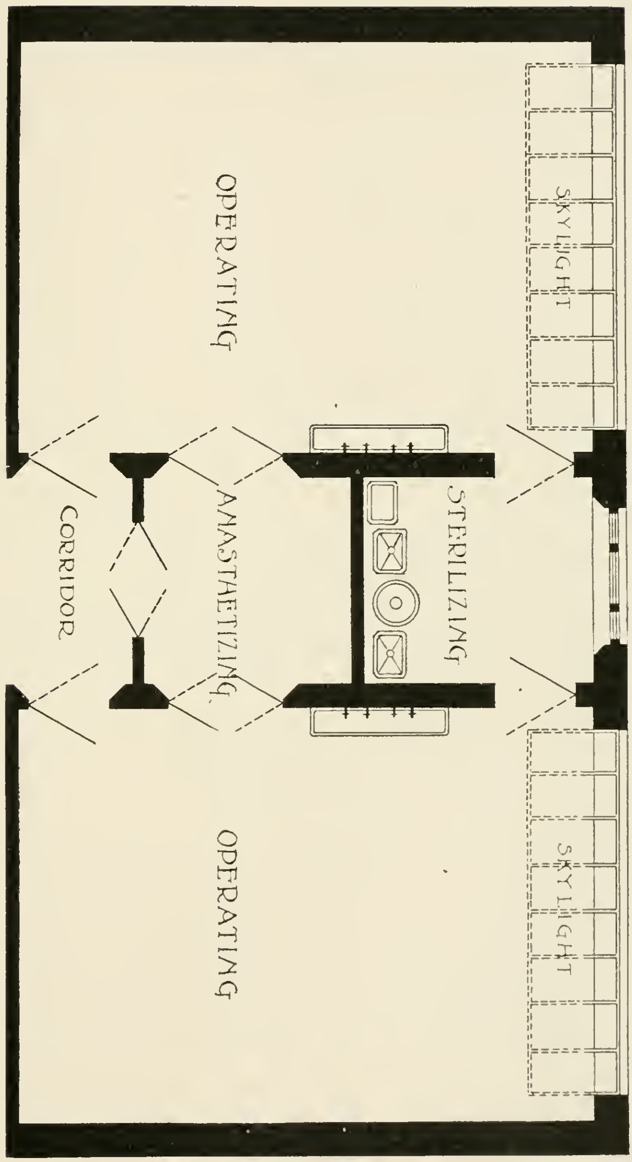
Fig. 338 shows an operating department, each operating room having an anesthetizing room and an instrument room. A sterilizing room, common to both, is placed as shown. This plan is particularly adaptable to building, as described herein.

Fig. 339 shows a plan for an operating department with both the anesthetizing room and sterilizing room serving both operating rooms.



Meyer J. Sturm, Architect.

FIG. 338.



Meyer J. Sturm, Architect.

FIG. 339.

THE
MANAGEMENT OF HOSPITALS.

CHAPTER XXVII.

GENERAL SUPPLIES.

CONTRACTS.

It may seem superfluous to speak of a matter so thoroughly established in the business world as that of contracts, materials and supplies, but those who have had no experience in the construction and management of hospitals—unless they are familiar with existing conditions—may find to their sorrow that there are certain elements which must be considered in order to buy the best at the lowest prices for the quality obtained. This has developed from the fact that in many communities materials and supplies for hospitals have not been purchased in the manner they would be were they intended for any other enterprise, for instance, the construction of a hotel. In advertising for "bids," it frequently happens that the Trustees of the institution feel bound to consider only those bids coming from the church, the society or the nationality represented by the particular hospital. This is true to such an extent that outside bidders do not as a rule consider it worth while to compete. One authentic instance will suffice to illustrate this fact. In the construction of a foundation for a hospital the bids of those who were presumably eligible because they belonged to the same nationality and church, varied from fourteen thousand to eighteen thousand dollars, while the bid of the contractor belonging neither to this church nor religious denomination amounted to eleven thousand five hundred dollars. The difference, therefore, between this and the lowest of the other bidders amounted to two thousand five hundred dollars, which would have given a profit of five hundred dollars to each of the five competing bidders. None of the five believed that the hospital organization would dare to employ a contractor who was not of their nationality and a member of their church; their high and exorbitant estimate was a result of the feeling of security against outside competition. In order to adjust this difficulty, the following fatal blunder is usually made by Boards of Directors: Bids are reopened, and the conditions explained to these various contractors who are members of the same nationality or belong to the same societies or religious organizations. All competitors are allowed to make

further estimates, when it will probably be found that the so-called inside competitors will have made bids equal to, or lower, than those of outside contractors. Directors are misled into taking this step because there are two distinct advantages to be gained from the method. In the first place, the institution obtains its contract at as low a rate as if the bids had been honest in the first instance; in the second place, the Trustees are not blamed for giving contracts to those outside in preference to their own people.

There is, however, an objection to this course, as it indicates to the outside contractors that it is useless for them to compete honestly, and consequently the field is left free to the dishonest competitors. In some communities this fact is so well known that contractors do not consider it worth while to spend the time necessary for estimating the cost of supplying the material which is called for by the contract, and consequently only those who are supposed to be on the available list compete for these privileges. It is an easy matter for these contractors to form combinations, to the detriment of the corporation. This condition is the result of the fact that these institutions ordinarily try to get more for the amount of money expended than other enterprises would expect from the same outlay, for after having made a contract, the contractor expects to be called upon for a donation for the institution, and he tries to protect himself against loss by over-charging in the first place, and then appearing to be generous or charitable by giving it back to the institution in the form of a donation.

With the introduction of the hospital as an important element in the community these objectionable features must cease, and the plan to be followed by any given institution is to explain to contractors that they are not to be called upon for donations, and if they wish to obtain the contract they must bid precisely as they would were they to compete for contracts for any other enterprise. It must also be explained to them that the contracts will be given to the lowest reliable bidder, without regard to any relation he may have to the institution in a social and religious way, or from the standpoint of his nationality.

THE GRADING OF MATERIAL AND SUPPLIES.

In this connection the matter of grading materials and supplies must be considered. It is not an uncommon experience in the construction and management of hospitals to find that one competitor will underbid the others to a very marked extent with the expectation of forcing upon the institution a quality of ma-

terial or supplies far below that called for by the contract. In case the contractor belongs to the same nationality, society or religious organization, it is often difficult to reject material and supplies which are below grade, but unless this is insisted upon the institution will receive a very poor quality of material and at a high cost, instead of receiving a high grade of material at a low cost. This is not an uncommon cause of waste in almost every department of maintenance of the institution.

In reviewing the lists of materials purchased one finds that in almost every item the amount of material of a good quality will go farther than a bad quality of material. This is not only true as regards the primary waste, but it also occurs in items like furniture, bedding, ward utensils, instruments, etc. One well-made article will outlast a number of poorly made. The natural care given to well-made things is much greater than that which is given to things of an inferior quality, which fact reduces the amount of waste in the first respect.

The point which is not to be underestimated in this connection comes from the establishment of a reputation for the institution of insisting upon the quality provided by the contract. Experience has shown that the institution which invariably rejects supplies that are below grade is certain to save a great amount during the year, because those who furnish the supplies find it unprofitable to have goods rejected, and they consequently take the pains to determine that their materials are up to grade before they are delivered.

In the larger institutions practically all the supplies can be contracted for at stated intervals. In these instances the ordinary form used for bids by business men in other industries should be employed and a careful record kept of all the bids received. A record should also be kept of the number of rejections made in connection with each contractor, for in this manner the institution can soon distinguish reliable contractors, which will, of course, be of great value in making future contracts.

In the smaller institutions which do not require supplies in sufficient quantities to make it profitable for important business houses to make contracts with them, it is best to use the following system: Some person with good judgment should visit the various establishments furnishing supplies, to determine the quality of goods and the prices. The firm giving the most favorable terms should be selected, with the understanding that the supplies are to remain of good quality, and the terms reasonable, and that so long as these requirements are maintained all of the supplies of

the character in question will be purchased from this establishment.

Observation has shown this—that several hospitals in the same city may purchase a given supply from a firm, and the one that buys from the same establishment year after year will find at the end of a year that the amount paid is from ten to twenty per cent less than that paid by other hospitals not following this system. This, however, is the case only if the institution pays its bills promptly. The reason is evident. Without the additional expense, which would be necessary were bills not paid promptly, the firm supplying the given material can make a small but constant profit, provided the slight amount of attention is given to the necessary inspection of supplies to determine their proper grade.

PURCHASING FOR CASH.

The plan of purchasing for cash is of sufficient importance to be considered separately. In buying from wholesale houses from two to six per cent can be saved on all bills by paying cash. All bills providing for a discount for cash should be paid at once, if necessary before they are audited, but they should be carefully audited, together with all of the other bills, once a week, in the larger institutions, and once a month in the smaller institutions. The fact of their having been paid before they were audited may occasionally give rise to some slight annoyance, but this is of no importance compared to the benefit derived by the institution in saving cash discounts.

It requires much greater ability to purchase supplies that are of high grade and still relatively inexpensive, than one inexperienced in hospital management might imagine, but the amount saved when supplies are purchased by some one who is experienced in this line is enough to enable even a small hospital to employ a person with proper judgment for this work.

WASTE OF LABOR AND MATERIAL.

Unless one has given the subject of waste in the management of hospitals close attention for a long period of time, it is impossible to comprehend how much material is ordinarily wasted in every department. In order to be specific in this matter, it may be well to point out the most common sources of waste, so that they at least may be guarded against.

Waste of labor depends very largely upon the plan of construction of the institution (this will be discussed in connection with the various illustrated plans in this work). We take, for

instance, the item of delivering the food to all patients in a hospital of a stated capacity; the amount of labor involved may be from two to ten times as great in hospitals variously planned, and which contain the same number of patients, because the total amount of distance to which the food has to be carried, and the provision for carrying the food will vary to this extent.

The matter of cleaning floors, walls and windows may imply a waste of labor in a hospital not planned with a view to economy in this direction. The same principle applies to the matter of heating, lighting and ventilation.

DRUGS.

In reviewing the expense of materials consumed we very frequently find a marked amount of waste in the item of drugs, which usually occurs in the following manner: The members of the staff being unfamiliar with the cost of the various drugs are likely to prescribe the more expensive article in case two remedies of equal value are considered, largely because the manufacturers of the more expensive remedies have taken the time and trouble to thoroughly advertise their products. This is true especially of many of the new imported remedies. Many of these cost the manufacturer scarcely as many cents per ounce as they receive dollars per ounce when they are sold to the hospitals. Being patented, the hospital has either to do without these remedies, or they must pay the enormous prices asked for them. The manner in which these remedies are introduced into a hospital is usually so well studied that unless the physician comprehends the system he will scarcely appreciate that he has been duped into becoming the means by which this waste is established in the institution.

In order to give this point practical application an instance may be given to illustrate. The manufacturer places one ounce of a valuable tonic, costing not to exceed three cents, in a twelve-ounce bottle with four ounces of whisky worth seven cents, and seven ounces of elixir worth two cents. To determine the merits of this remedy he supplies to the institution, free of charge, one-half a gross of twelve-ounce bottles. The patient is given one-fourth to one-half an ounce of this mixture three times a day, and receives the tonic effect. In this manner the remedy becomes established. The experiment has cost the manufacturer less than twelve dollars, but as a result the staff has become accustomed to prescribe the remedy in a routine way. As soon as the free supply is exhausted the hospital begins to purchase it at nine dollars per dozen bottles, which is more than six times the actual cost of the remedy. No one concerned appreciates the fact that an item

of waste has occurred, and yet there has been what would be considered in any other enterprise a great amount of waste.

Another source of waste in the matter of drugs comes from the faulty system of prescribing for each patient a given quantity of a mixture, and then giving only a small portion of it, throwing away the remainder because the exact formula might not be suitable for any other patient in the near future. If the attention of the staff is directed to these facts this source of loss can be avoided, but unless attention is given the matter of waste will amount to at least one-half of the drug bill. No one outside of the members of the staff can possibly prevent this, because they are the only ones connected with the institution who are competent to judge of the value of remedies.

There is a laudable tendency in medical men employed in hospital practice to make their work thoroughly modern. This necessitates the study of the newer remedies in their clinical application. The younger assistants are likely to be especially enthusiastic over these observations, and as a result many expensive remedies must necessarily be tried. So long as these observations are carefully made the amount of benefit usually equals, or exceeds, the harm that results. Unfortunately the remedies are likely to be continued in use long after their uselessness has been practically demonstrated. The profit to the manufacturer is so great that he can well afford to push the remedies systematically with the new assistants in hospitals where there is rotation in service. It is, therefore, worth while to examine the shelves in the drug rooms in hospitals to observe the number of these remedies that accumulate, and members of hospital staffs should bear these things in mind, as a large amount of waste may be eliminated by a little attention to these details.

FOOD.

The possibilities of waste in food supplies in hospitals is very great, especially in this country. In European countries this subject has been thoroughly studied. The degree of perfection attained in the item of saving food in private families, and in hotels there has reached such perfection that it would be well worth while to study the results in connection with this item of waste in our hospitals. The important point to be gained from them is the conviction that practically every particle of food purchased can be made palatable and valuable from the point of nutrition.

In this country milk, which should constitute a large portion of the food of hospital patients, can always be obtained at a comparatively small expense. It is also possible to obtain milk of

excellent quality, if the source of supply is carefully inspected. The large hospitals should obtain all of their milk from one farm on which cows have been carefully tested for tuberculosis, and where the manner of handling the milk is carefully prescribed. The feeding of the cows, the water supply, the cleanliness and general hygiene of the stables, should all be under strict supervision. Milk cans should be sterilized, and the milk scientifically cooled and preserved in a separate room with an even temperature. This will be described later in connection with building plans. The milk should be delivered in sealed cans to the hospital.

Having provided the institution with a good quality of milk and a proper place for storing the general supply, it is important to provide means for delivering this milk in a wholesome condition to the patient. It is, of course, impossible for the nurse to go to the general supply room for every glass of milk used. This would make it possible for contamination to occur between the time of leaving the general supply room and delivering it to the patient, unless provision is made for keeping it in proper refrigerators, and in aseptic receptacles on the various floors.

If the milk is placed in the same refrigerator with other articles of food it will soon absorb a sufficient amount of odor from such foods to make it unpalatable. The diet-kitchen on each floor should contain a sterilizer sufficiently large to permit the introduction of the milk cans which are used on the various floors. As soon as a can is emptied it must be thoroughly washed and then boiled for twenty minutes in a solution of an ounce of baking soda to four gallons of water. They are then well rinsed with boiling water and placed in the ice box to cool before refilling. If the sterilizers on the various floors are not large enough to contain these cans, they should then be carefully washed with hot water and soda, then filled completely with boiling water and permitted to stand for half an hour, after which they may be delivered to the general supply room, where they should be sterilized and cooled before they are used. These cans should be made of block tin to prevent them from rusting.

Unless these precautions are taken there will be a considerable waste in the milk supply.

Too much attention cannot be given to the milk supply. If milk is wholesome and palatable most patients will be better nourished, during the greater portion of their stay in the hospital, on a milk diet, than on any other diet that may be devised. If the milk is obtained from healthy animals which have been properly fed and scientifically cared for, it is sure to be palatable to many

patients who cannot ordinarily take it. And it is of great importance, manifestly, to give careful attention to the matter of diet in a very specific way. This attention should be given by a person whose judgment is good in such matters, and by one who can also give direct supervision to the matter of economy in connection with that of diet.

With these two points carefully watched and considered, the patient will receive the food that is best for him, and there will be no unnecessary waste.

These facts apply to all food substances. The amount of meat, for instance, which is properly used in feeding a given number of patients is very small; there is scarcely a patient who can profitably consume more than one or two ounces of meat at a meal. If, however, this patient is given a steak weighing half a pound, there will be a waste of three hundred per cent, and the patient will not be as well satisfied as he would had the steak been divided in four portions and delicately served to four patients.

The same is true of all other foods: a small amount of vegetable, a thin slice of bread, will be far more acceptable to the patient, and he will undoubtedly get more nourishment from a meal served in this manner than he would were he offered four times the amount.

Food should be delivered *hot* to the patient. This is not easy to accomplish, even in a properly constructed and well-managed institution, but it can be done if the importance of the point is fully appreciated by those in charge of the department. This is of so much importance to the prosperity of the institution, as well as to the comfort of the patient, that it may be well to reiterate the advantages to be gained from serving small portions of daintily arranged, hot, and therefore attractive, palatable food. The patient will profit by being tempted to eat more; he will better digest a meal which is made attractive to him, and will consequently get greater benefit from it. The institution will benefit from the praise given it by well-satisfied, enthusiastic patients, as well as from the materials saved in this department.

SAVING WASTE MATERIALS.

Each new patient should, of course, be supplied with a fresh piece of soap, which will mean a great many small, or left-over, pieces. All of these should be saved and occasionally boiled up into some form of soft soap to be used for washing or cleaning purposes.

All butter and fat which is left over from cooking or from

the trays can be utilized in making soap if a soap machine is employed. This can be arranged for in connection with the laundry machine.

It would be useless to attempt to enumerate all the details through which this saving of waste material may be carried. In the housekeeping department the opportunities are especially numerous; the few instances mentioned will serve as examples.

SURGICAL DRESSINGS.

The prevention of waste in surgical dressings is one of the leading items in hospital management. The dangers from using over again dressing materials which have come in contact with infected wounds are so great that the natural tendency of most surgeons is to discard everything that has once been used; and then there is a constant tendency to make dressings unnecessarily large. As a result of these facts a system of waste is developed which aggregates much more in most institutions than the amount actually required for conducting the work in the best possible manner. There will always be waste here, but if the surgeons in charge will give reasonable attention the amount can be reduced to a minimum. If, however, the surgeon himself is wasteful, no admonition to the assistants in the department will be of benefit in preventing unnecessary loss. In a few of the best organized hospitals in the country a great amount is saved by sterilizing over again all of the dressings which have been used in non-septic cases.

If all dressings are delivered from a central supply room by a competent nurse who personally superintends their sterilization, there can be no doubt of their being perfectly safe to use in redressing septic cases. These packages of dressings should be covered with a muslin cover sufficiently thick to prevent infection from the time they are sterilized until they are used.

SURGICAL INSTRUMENTS.

There are also great possibilities of waste in the purchasing of surgical instruments, in which there are two different systems used. According to the first system the hospital purchases a fair supply of those instruments which are constantly used, such as dissecting forceps, hemostatic forceps, scalpels, steel sounds, probes, retractors, scissors, needles, needle holders, chisels, trocars, etc. Later on as special instruments are required, like trephines, gastro-enterostomy clamps, lithotrites, these also are obtained. In each instance the simplest form of instrument is chosen because it has the greatest range of usefulness.

According to the second system the members of the staff select instruments that might be required to cover every possible emergency in their department. They also supply their department with everything new and intricate in the way of surgical instruments and appliances. This plan will, of course, furnish all of the instruments secured under the first system, and in addition a large number which are ingeniously planned to do certain things specially well. In comparing the reports of two institutions in which approximately an equal amount of surgical work is being done, the cost of surgical instruments according to the second system is nearly twelve times as great as the amount expended for instruments according to the first system.

As a rule the quality of work is superior in the institution using the simpler form of appliances. From using them constantly the surgeon becomes familiar with each individual instrument, and is consequently able to reduce the amount of traumatism to a minimum.

FUEL.

The waste in fuel comes chiefly from badly planned systems of heating and ventilation. These systems will, of course, be fully considered later on, when it will be demonstrated that in order to secure sufficient ventilation a considerable amount of heat must be wasted, but with careful attention in this department much saving can be accomplished, where ordinarily much is lost. One saving item of great importance is the plan of having steam piped from the general heating plant to the various service rooms for the purpose of sterilizing and heating dishes, for cooking, etc.

Much space could be consumed in discussing all the possible details of economy in the various departments, but it seems better to point out the possibilities of economy in a general way in order that those in charge of these departments may develop systems applicable to the specific conditions under which they exist.

CHAPTER XXVIII.

HOSPITAL FINANCES.

It is of the greatest importance to place the financial end of every enterprise upon a sound basis in order to establish permanence and prosperity. This fact becomes more important as the element of competition is introduced.

An institution with an excellent financial system must have a great advantage over its competitor with a defective system. The difference between these two systems is not so apparent in the early organization of an institution as it becomes a few years later, because any deficit which may occur at the end of the year is usually disposed of by a suitable donation from some philanthropic friend. In this manner the work for the following year is not seriously hampered by the bad financial management of the one preceding.

Very recently, however, there has been a change in the methods of philanthropists; many of them now take the precaution to have the past financial management of an institution examined by an expert before supplying funds for its future support. This method is certain to become generally adopted, and consequently it will be necessary to establish reliable systems in order to share in the contributions from these public-spirited citizens. Instead of *apparent* philanthropy this will develop *real* philanthropy, and as a result of this change there will be a natural selection in favor of those institutions which appreciate this step in advance, and which must result in the "survival of the fittest."

In establishing a financial system the first step must be in the direction of a simple but very comprehensive system of bookkeeping.

If the system be simple any fairly educated person can be taught to perform the work perfectly, and therefore it will not be necessary to employ an expensive bookkeeper. If the system is thoroughly adapted to the needs of the institution the results will be quite as satisfactory as though much more money were expended in this service. In more than ninety per cent. of all hospitals in this country this item of economy is of real importance.

In order to have perfect results in the system, two points

should be borne in mind—viz., the person keeping the books must be accurate in carrying out the plan, and the books must be regularly audited by a committee, preferably of three expert bookkeepers who are independent of the institution and are not members of the Board of Trustees.

Accuracy in work is a habit, and if the bookkeeper does not possess this habit another should be employed who does. It may even be necessary to make a number of changes before the proper person is found, but it *is* possible to secure the right person with the necessary qualifications at a salary which is consistent with the financial condition of the institution in question.

Every institution in moderate financial circumstances may have among its friends a sufficient number of expert bookkeepers who would gladly assist in auditing the books of the hospital. The income of these bookkeepers may not permit them to give financial aid to the institution, but by giving this personal service, which is in itself decidedly valuable, they feel that they have been helpful toward making a success of a worthy charity.

In the large and wealthier institutions an expert accountant should be employed to audit the books from time to time.

In the hospitals on the continent in Europe the financial system is entirely in the hands of the authorities of the government or city, and there is consequently in vogue a system which is accurate, although in many instances very cumbersome.

In England the subject of hospital finances has been greatly developed, especially through the unceasing activity of Sir Henry C. Burdett, who has remarkable ability as a business man, has dealt with important financial questions for many years, and is especially fitted to organize this department of hospital management. It has been his aim for years to establish a uniform system for all hospitals in England which are controlled by charitable organizations. This implies for these institutions a uniform system of bookkeeping, and a uniform system of maintaining records.

It is difficult to make a comparative study of the annual reports of hospitals in this country because of the lack of uniformity in keeping records, which makes it quite impossible to arrive at any fair conclusions. In each case it seems to be the object of the document to make the best possible showing for the institution without regard to the methods employed to obtain such results, and without following any definite system of recording the facts upon which the conclusions are based.

A committee of the Association of American Hospital Superintendents has made a careful study of these methods, and has produced what may be taken as a basis for a system which can be

generally applied. This should result in uniformity in the matter of financial reports for American hospitals.

This committee was composed of some of the most experienced and capable hospital men in the country, who gave a great amount of time and thought to the study of this subject, and consequently it seems wise to incorporate their system of keeping uniform hospital records in this work, and to recommend it generally to hospital authorities.

There are many reasons why this plan should be generally adopted. It is comprehensive and at the same time simple. It will facilitate comparisons between the various institutions. It will establish precedent upon an accurate basis. It will eliminate apparent and substitute real results. It will substitute a uniform system devised by experts for systems introduced into the various institutions by amateurs.

The following forms here introduced have been adopted by four of the leading hospitals of this country because they are the results of careful study and are already practically in use, consequently they are beyond the experimental stage. This plan provides comparative reports for two years. If preferred the reports for three years could be introduced for comparison.

SCHEDULE 1.

Detailed Statement of Operating, Corporation and Other Current Expenses.

Administration Expenses:

	1906.	1905.
Salaries, Officers and Clerks		
Office Expenses		
Stationery, Printing and Postage		
Telephone and Telegraph		
Legal Expenses		
Miscellaneous		
Total Administration Expenses		

Professional Care of Patients:

		1906.	1905.
SALARIES AND WAGES:			
	Physicians		
	Supt. of Nurses, Assistant and Instructors		
	Nurses		
	Special Nurses		
	Orderlies		
	Special Orderlies		
	Ward Employees		
EQUIPMENT FOR NURSES:			
	Uniforms		
	Books		
	Instruments		
MEDICAL AND SURGICAL SUPPLIES:			
	Apparatus and Instruments		
	Medical Supplies		
	Surgical Supplies		
	Alcohol, Liquors, Wines, etc		
DISPENSARY:	Salaries and Labor		
	Supplies		
EMERGENCY WARD:	Salaries and Labor		
	Supplies		
VISITING AND HOME (DISTRICT) NURSING	Salaries		
	Supplies		
Total Professional Care of Patients			

Department Expenses:

		1906.	1905.
AMBULANCE:	Labor		
	Supplies		
PATHOLOGICAL LABORATORY:	Salaries and Labor		
	Supplies		
TRAINING SCHOOL:	Salaries and Labor		
	Supplies		
HOUSEKEEPING.	Labor		
	Supplies		
KITCHEN:	Labor		
	Supplies		
LAUNDRY:	Labor		
	Supplies		

SCHEDULE I—Continued.

Department Expenses—Continued:

	1906.	1905.
STEWARD'S DEPARTMENT:		
Labor		
Provisions:		
Bread		
Milk and Cream		
Groceries		
Butter and Eggs		
Fruits and Vegetables		
Meat, Poultry and Fish		
Total Steward's Department		
Total Department Expenses		

General House and Property Expenses:

Electric Lighting		
Fuel, Oil and Waste		
Gas		
Ice		
Insurance		
Maintenance, Real Estate and Buildings		
Maintenance, Machinery and Tools		
Plumbing and Steam Fitting		
Photography		
Rent		
Miscellaneous		
Total General House and Property Exp		
Total Operating Expenses		

Corporation or Other Current Expenses:

Salaries, Officers and Clerks		
Stationery, Printing and Postage		
Legal Expenses		
Interest on Mortgages or Loans Payable		
Taxes		
Miscellaneous		
Total Corporation Expenses		
Current Expenses from Special Funds for Stated Purposes: (Show expenditure from each fund separately.)		
Grand Total Current Expenses		
Excess of Current Revenue over Current Exps		
TOTAL		

SCHEDULE 2.

Detailed Statement of Current Revenue.

Hospital Receipts:
(or Operating Receipts.)

	1906.		1905.	
Private Room Patients				
Board of Friends of Patients				
Ward Pay Patients				
Special Nursing				
Dispensary				
Emergency Ward				
Ambulance Fees				
Miscellaneous				
Total Hospital Receipts				
Other Revenue or Income:				
From the Public Treasury				
Donations from Individuals to meet Current Expenses				
Donations from Churches to meet Current Expenses				
From Hospital Saturday and Sunday Ass'n.				
Net Receipts from Entertainments, Fairs, Fetes, etc.				
Legacies, unrestricted				
Profits on Investments sold				
Revenue from Investments or Funds for Current Use				
Miscellaneous				
Total Other Revenue or Income				
Income from Special Funds for Current Expenses: (Show income account each fund separately.)				
Grand Total Current Revenue				
Excess Current Expenses over Current Revenue				
TOTAL				

SCHEDULE 3.

Summary of Financial Transactions for the Year Ended September 30, 1906.

Capital Expenditures:

	1906.	1905.
Additions to Sites and Grounds		
Additions and Betterments, Buildings		
Furniture and Fixtures (If chgd. to Capital Acct.)		
New Machinery (If chgd. to Capital Acct.)		
Apparatus and Instruments, do.		
Ambulances, Live Stock, etc., do.		
Miscellaneous		
Total Capital Expenditures		

Surplus Account:

Grand Total Current Expenses, Schedule 1.		
Loss and Depreciation		
(Show items separately if desired.)		
Total		
Surplus for the year		
Total		

SCHEDULE 3.

Summary of Financial Transactions for Year Ended September 30, 1906.

Capital Receipts:

	1906.	1905.
Fully Endowed Beds		
Partly Endowed Beds		
General or Special Funds or Gifts for other than Current Expenses		
(Show receipts account each fund or gift separately.)		
Total Capital Receipts		

Deficit Account:

Grand Total Current Revenue, Schedule 2		
Amount charged off Endowed Bed Fund or other Fund Reserves account liability of Hospital having ceased		
Total		
Deficit for the Year		
Total		

SCHEDULE 4.

Comparative Balance Sheet for Years Ended September 30th, 1906 and 1905.

Capital Assets:

HOSPITAL PROPERTIES AND EQUIPMENTS:	1906	1905	Increase.	Decrease.
Sites and Grounds				
Buildings				
Furniture and Fixtures				
Machinery and Tools				
Apparatus and Instruments				
Ambulances, Live Stock, etc.				
Miscellaneous				
INVESTMENTS:				
Mortgages Receivable				
Bonds				
Stocks				
Other Investments				
Total Capital Assets				
Current Assets:				
Loans and Notes Receivable				
Accounts Receivable				
Accounts Receivable from Public Treasury				
General Material on Hand				
Cash in hands of Treasurer				
Cash in hands of Superintendent				
ADVANCES:				
Prepaid Insurance				
Other Prepaid Expenses				
Total Current Assets				
Grand Total Assets				
Deficit				
Total				

SCHEDULE 4.

Comparative Balance Sheet for Years Ended September 30th, 1906 and 1905.

Capital Liabilities:

	1906	1905	Increase.	Decrease.
Capital Account (Hospital Properties and Equipments)..........	....	....	....	....
Endowed Bed Fund Reserves....	....	....	....	....
Partly Endowed Bed Fund Reserves	....	....	....	....
Other Fund Reserves	....	....	....	....
(List each separately.)				
....	....	....	....	....
....	....	....	....	....
Bonds Outstanding on Hospital Property	....	....	....	....
Mortgages Payable	....	....	....	....
Total Capital Liabilities	....	....	....	....

Current Liabilities:

	1906	1905	Increase.	Decrease.
Loans and Notes Payable	....	....	....	....
Audited Vouchers Unpaid or Accounts Payable	....	....	....	....
Total Current Liabilities	....	....	... ...	....
Grand Total Liabilities........	....	....	....	... .
Surplus..	....	....	....	....
Total	....	....	....	....

SCHEDULE 5.

Statement Showing Increase or Decrease of Principal of all Capital Funds During Year Ended September 30, 1906,

Description of Funds.	Amount Sept 30, 1905.	Received During Year.	Expended During Year.	Amount Sept. 30, 1906.	Increase.	Decrease.
TOTAL						

SCHEDULE 6.

Comparative Statistics for Years Ended September 30, 1906 and 1905

Hospital Wards and Private Rooms.

	1906		1905	
PATIENTS IN HOSPITAL FIRST OF YEAR:				
In Medical Wards, Male				
Female				
In Surgical Wards, Male				
Female				
In Private Rooms, Male				
Female				
Total				
PATIENTS ADMITTED DURING YEAR:				
To Medical Wards, Male				
Female				
To Surgical Wards, Male				
Female				
To Private Rooms, Male				
Female				
Total				
TOTAL PATIENTS TREATED IN HOSPITAL WARDS AND PRIVATE ROOMS DURING YEAR				
Male				
Female				
PATIENTS DISCHARGED DURING YEAR:				
Cured				
Improved				
Unimproved				
Transferred to other institutions				
Died				
Total				
PATIENTS IN HOSPITAL END OF YEAR:				
In Medical Wards, Male				
Female				
In Surgical Wards, Male				
Female				
In Private Rooms, Male				
Female				
Total				
TOTAL PATIENT DAYS TREATMENT:				
Free Ward				
Endowed Bed				
Pay Ward				
Private Room				
Total				
PERCENTAGE:				
Free Ward Days				
Endowed Bed Days				
Pay Ward Days				
Private Room Days				
AVERAGE PATIENTS PER DAY:				
Free Ward				
Endowed Bed				
Pay Ward				
Private Room				
Total				
Average Time per Patient in Hospital				
Daily Average Cost per Private Room Patient				
Daily Average Cost per Ward Patient				

SCHEDULE 6—Continued.

Emergency Ward.

		1906.	1905.
Patients Under Treatment first of year,	Male		
	Female		
Patients Admitted during year,	Male		
	Female		
Total Patients Treated during year,	Male		
	Female		
Patients Discharged during year,			
Patients Under Treatment end of year.	Male		
	Female		
Visits made to Emergency Ward during year,			
Average Visits made per day,			
Average Visits per Patient			
Daily Average Cost per Emergency Ward Patient.			

Dispensary.

		1906.	1905.
Patients Under Treatment first of year,	Male		
	Female		
Patients Admitted during year,	Male		
	Female		
Total Patients Treated during year,	Male		
	Female		
Patients Discharged during year.			
Patients Under Treatment end of year,	Male		
	Female		
Visits made to Dispensary during year,			
Average Visits per day.			
Average Visits per Patient			
Daily Average Cost per Dispensary Patient			

Ambulance.

	1906.	1905.
Ambulance Calls during year		
Average Calls per day		
Average Cost per Ambulance Call		
Patients Treated by Ambulance Surgeon in Emergency Ward and Transferred		
Patients Treated by Ambulance Surgeon and left at place of call or transferred direct to other Institutions		

Visiting or Home (District) Nursing.

	1906.	1905.
No. of Patients Visited		
No. of Visits Made		
Average Visits per day		
Average cost per visit		

Summary.

	1906.	1905.
Total Patients Treated during year in all Departments		
Average Patients per day in all Departments		
Daily average number of Employees Boarded in Hospital		
Daily Cost per capita for Provisions for all persons supported		

INSTRUCTIONS REGARDING DISTRIBUTION OF HOSPITAL OPERATING, AND CORPORATION OR OTHER CURRENT EXPENSES.

ADMINISTRATION EXPENSES.

1. *Salaries, Officers and Clerks.*

This account includes the salaries of general officers of the hospital and their assistants or clerks, whose salaries are not directly chargeable to any department.

This account should not include salaries of officers or clerks who are exclusively engaged with the management of the corporation, estate or sources of revenue outside of the ordinary receipts of the hospital proper. If certain officers or clerks are partly engaged in this manner, a proper proportion of their salaries should be charged accordingly.

2. *Office Expenses.*

This account includes the cost of traveling expenses of employes, car fares, express charges, messenger service, subscriptions to newspapers and periodicals, office furniture and fixtures, and such other office supplies as are not properly chargeable to any other subdivisions of administration expenses or to corporation expenses.

3. *Stationery, Printing and Postage.*

This account includes the cost of printing annual reports, blank books, blank forms, paper, stationery, stationery supplies, etc., used in the general work of the hospital. It should not include expenditures of this nature made for corporation purposes.

4. *Telegraph and Telephone.*

This account includes all expenditures, account telegraph messages, rent of telephones, salaries of operators or maintenance of telephones and telephone lines.

5. *Legal Expenses.*

This account includes all fees and retainers paid for services of attorneys, costs of suits and all legal and court expenses incurred in the operation of the hospital. It should not include expenditures of this nature made for corporation purposes.

6. *Miscellaneous.*

This account includes such other administration expenses as are not directly chargeable to any of the foregoing accounts, or to corporation expenses.

PROFESSIONAL CARE OF PATIENTS.

7. *Salaries and Wages.*

This account includes the salaries and wages of employes under the various headings named.

8. *Equipment for Nurses.*

This account includes the cost of uniforms, books and instruments, if furnished to the nurses by the hospital.

If uniforms, books and instruments are purchased by the hospital, to be paid for later by the nurses, they should be charged to the general material account, and that account should be credited when these are paid for by the nurses.

9. *Medical and Surgical Supplies.*

This account includes the cost of apparatus and instruments, medical and surgical supplies, and alcohol, liquors, wines, etc., purchased for the general use of the hospital, not specifically chargeable to any department.

It would not, however, inclunde the purchase of apparatus and instruments in large quantities to equip new and additional buildings, which should be charged to capital account, under the heading provided therefor.

10. *Dispensary.*

(a) Salaries and Labor. This account includes the salaries and wages of physicians, assistants, nurses and any other employes in this department.

(b) Supplies. This account includes the cost of all apparatus and instruments, medical and surgical supplies, and any other supplies whatsoever, which are properly chargeable to this department.

11. *Emergency Ward.*

(a) Salaries and Labor. This account includes the salaries and wages of physicians, assistants, nurses and any other employes in this department.

(b) Supplies. This account includes the cost of all apparatus and instruments, medical and surgical supplies and any other supplies whatsoever, which are properly chargeable to this department.

12. *Visiting or Home (District) Nursing.*

(a) Salaries. This account includes the salaries of nurses employed in this service.

(b) Supplies. This account includes the cost of all medical and surgical supplies, food, clothing, or any other supplies whatsoever purchased for this service for use of patients.

DEPARTMENT EXPENSES.

13. *Ambulance.*

(a) Labor. This account includes the wages of all employes in this department; also the cost of any other labor in connection with making repairs or maintaining the equipment of this department.

(b) Supplies. This account includes the cost of all equipment and supplies of any nature which are properly chargeable to this department; also, the cost of any material used in making repairs or maintaining the equipment of this department. It should not include, however, new and additional equipment, such as ambulances, live stock, etc.

It is considered more proper to charge such new equipment to capital account, under the heading provided therefor.

14. *Pathological Laboratory.*

(a) Salaries and Labor. This account includes the salaries and wages of physicians, assistants and any other employes in this department, including amounts paid for cost of labor in making repairs or maintaining the equipment of this department.

(b) Supplies. This account includes the cost of all apparatus and instruments, medical and surgical supplies, and any other supplies whatsoever, which are properly chargeable to this department; also, the cost of any materials used in making repairs or maintaining the equipment of this department.

15. *Training School.*

(a) Salaries and Labor. This account includes the salaries and wages of officers, instructors, and any other employes which are chargeable exclusively to the cost of operating and maintaining the training school, and which cannot properly be charged to any other account.

(b) Supplies. This account includes the cost of supplies and materials which are directly chargeable to the cost of operating and maintaining the training school exclusively, but does not include the cost of supplies for housekeeping, kitchen, laundry, steward's department, and general house and property expenses in connection with the training school, which should be charged under their respective headings elsewhere, together with other expenses of similar character for the general hospital, as it does not seem desirable to further subdivide the training school account.

16. *Housekeeping.*

(a) Labor. This account includes the salaries and wages of the housekeeper and all persons employed in this department, including waitresses, chambermaids, scrubwomen, porters, etc., etc.; also, all persons employed in making and maintaining housekeeping supplies and in cleaning, etc., chargeable to the general hospital and training school, and not chargeable to any other department.

(b) Supplies. This account includes the cost of furniture and fixtures, such as beds, bedding, chairs, tables, tableware, linen, and all other housekeeping supplies. It also includes the repairs

of same. It should not include, however, large quantities of new and additional furniture.

It is considered more proper to charge these to capital account, under the heading provided therefor.

17. *Kitchen.*

(a) Labor. This account includes wages and labor of all persons employed in this department, in connection with the preparation and general distribution of all food.

(b) Supplies. This account includes the cost of all kitchen utensils, fuel used in the kitchen range and other supplies and materials chargeable to the operation and maintenance of the kitchen, not including, however, provisions mentioned under the heading of steward's department.

18. *Laundry.*

(a) Labor. This account includes the wages of employes engaged in this department or the cost of laundry work done outside. It also includes the cost of any labor in connection with repairs or maintenance of equipment of this department.

(b) Supplies. This account includes the cost of all supplies used in this department, including the materials used in connection with operating and maintaining the equipment of this department.

19. *Steward's Department.*

(a) Labor. This account includes the wages of all persons employed in receiving, storing and distributing the supplies of this department.

(b). Provisions.

Bread—This account includes the cost of all bread, cake, pastry, etc., purchased.

Milk and Cream.—This account includes the cost of all milk, cream, cheese and ice cream purchased.

Groceries.—This account includes the cost of all groceries, canned goods, flour, dried fruit, etc.

Butter and Eggs.—This account includes the cost of all butter and eggs.

Fruits and Vegetables.—This account includes the cost of all fresh fruits and fresh vegetables.

Meat, Poultry and Fish.—This account includes the cost of all meat, whether fresh, dried or smoked, and of poultry, game, fish, and all sea food.

GENERAL HOUSE AND PROPERTY EXPENSES.

20. *Electric Lighting.*

This account includes the cost of all labor, supplies and ma-

terials used in connection with operating and maintaining the electric lighting plant, not including, however, the cost of maintaining machinery used in connection with same, which is chargeable to maintenance, machinery and tools. It includes the cost of maintaining electric lamps, fixtures or wiring, but does not include the cost of operating steam plant or dynamos, which is chargeable to maintenance, machinery and tools. This account of electric lighting includes the cost of any electric light, if furnished from outside.

21. *Fuel, Oil and Waste.*

This account includes the cost of all fuel, oil and waste used in connection with operating and maintainig the power, lighting and heating plant, but does not include the cost of fuel used in the kitchen or laundry range.

22. *Gas.*

This account includes the cost of all gas.

23. *Ice.*

This account includes the cost of all ice.

(If refrigerating plant is used, indicate by foot note.)

24. *Maintenance Real Estate and Buildings.*

This account includes the cost of all labor and materials used in connection with repairs and maintenance of real estate and buildings in the hospital group. It includes the cost of repairs to fences, sidewalks, and the cost of keeping sidewalks and grounds in good order, shoveling snow, etc.

This account should not be charged with repairs and renewals of furniture and fixtures, such as beds, bedding, chairs, tables, tableware, etc., which are chargeable to housekeeping supplies.

This account does not include the cost of new and additional real estate and buildings. It is thought more proper to charge the cost of these to capital account, under headings provided for sites and grounds or buildings.

25. *Maintenance, Machinery and Tools.*

This account includes the cost of all labor or materials used in connection with repairs, maintenance and renewals of boilers, stationary engines, dynamos, pumps and other machinery, including the shafting, belting and other appliances for running machinery and all tools and fixtures used in connection therewith.

It includes the wages of engineers, firemen, etc., not directly chargeable to other accounts.

This account should not include the cost of machinery for new buildings. It is considered that this is more properly chargeable to this heading under capital account.

26. *Plumbing and Steam Fitting.*

This account includes the cost of all labor and materials used

in connection with repairs and renewals of all water, gas or steam pipes and fittings.

27. *Photography.*

This account includes the cost of all labor and materials used in the X-ray department or other photographic work or supplies.

28. *Rent.*

This account includes the cost of rental of buildings used in connection with hospital work.

29. *Insurance.*

This account includes the cost of all insurance for account of the hospital.

30. *Miscellaneous.*

This account includes the cost of any labor and materials chargeable to general house and property expenses, not included in any of the headings already provided for.

CORPORATION OR OTHER CURRENT EXPENSES.

31. *Salaries, Officers and Clerks.*

This account includes salaries of officers and clerks, who are exclusively engaged with the management of the corporation, estate or other sources of revenue outside of the ordinary receipts of the hospital proper.

If certain officers or clerks are partly engaged in this manner a proper proportion of their salaries should be charged accordingly.

32. *Stationery, Printing and Postage.*

This account includes expenditures of this nature for corporation purposes, including soliciting donations, etc.

33. *Legal Expenses.*

This account includes expenditures of this nature made for corporation purposes.

34. *Interest on Mortgages and Loans Payable.*

This heading explains itself.

35. *Taxes.*

This account includes all taxes paid on property owned by the hospital for investment.

36. *Miscellaneous.*

To this account should be charged any other corporation or current expenses not properly chargeable to any of the other headings provided.

37. *Current Expenses from Special Funds for Stated Purposes.*

(Show expenditure from each fund separately.)

This account explains itself.

BOOKKEEPING.

In order to establish uniformity in bookkeeping it is proper to select the least complicated and most comprehensive plan which has been in actual use in hospitals whose officers have kindly furnished the necessary data.

This system contains the following books.

Cash Book.

Journal.

Invoice Book.

General Ledger.

Patients.

Patients' Register.

CHARITY ACCOUNTS.

There should be a definite system of bookkeeping introduced in connection with funds contributed for charitable purposes.

A ledger should be kept showing the amounts credited and charged to the various accounts, and a report should be made at the end of the year stating exactly what had been done with the money contributed by the various individuals and organizations.

This is important especially in institutions supported by church organizations. For instance, a given church has contributed one hundred dollars toward the support of the hospital; therefore its account should be credited with this amount. Then, the congregation sends a charity patient to the hospital for twenty days at an expense to the hospital of $1.25 per day. The amount of twenty-five dollars should be charged against the account. At the end of the year a statement should be sent to this particular church setting forth the condition of its account. Such statement should contain the name, address, occupation and age of the patient, by whom sent, the condition for the relief of which the patient entered the hospital, the department in which the patient was treated, and the condition of the patient when discharged. It might be better to substitute for the name and address the number of the case history through which the identity of the patient could be established by referring to the records in the office of the hospital. The important point, however, is to give the donor of the contribution an opportunity to see what good had actually been accomplished with his money, which will act as an incentive to further financial support for the institution. At the same time the authorities at the hospital will be compelled to make a direct record of every case for which money has been expended, and they will have to charge a definite amount to a definite account.

The following two forms will give a clear idea of the impression their use will make upon one's mind. Each form represents a donation of one hundred dollars. Each donor presumably supposes that he has done one hundred dollars' worth of good by contributing this amount to the hospital. As a result of this donation, donor number one finds that four persons have been restored to health and thus enabled to support themselves and their families. There has been supplied to them such care and treatment as could not have been secured in their own homes, not having the means with which to employ trained nurses; neither could they afford the services of skilled physicians and surgeons, without which service one or two of them at least might not have recovered. The community at large is benefited because of the restoration to full working capacity of useful members of society.

FORM 5.

STATEMENT.

Chicago, ..., 1906.

M....................................

....

In account with .... Hospital.

Charity Fund.

Jan. 1	—By cash donation		$100.00
Mar. 8	—To 21 days' hospital care at $1.50, case No. .... Housewife, pneumonia.	$ 31.50	
Mar. 12	—To 7 days' hospital care, children's ward, at $1.. Acute enteritis, case No.	7.00	
July 8	—To 35 days' hospital care, at $1.50, case No..... . Brick carrier, fractured leg.	52.50	
Aug. 17	—To 6 days' hospital care, at $1.50, case No. .... Tailor, infected hand.	9.00	
Nov. 10	—To 5 days' hospital care, at $1.50, case No..... Machinist. Fractured arm, patient returns to out patient department.	7.50	
		$ 97.50	
	For dressings	$ 2.50	
		$100.00	$100.00

FORM 6.

STATEMENT.

Chicago, ..., 1906.

M...............................

....

In account with .... Hospital.

Charity Fund.

Jan.	1—By cash, donation		$100.00
Mar.	8—To 20 days' hospital care, at $1.50, case No..... Unemployed vagrant.	$ 30.00	
April	6—To 18 days' hospital care, at $1.50, case No. .... Acute alcoholism.	27.00	
June	10—To 6 days' hospital care, at $1.50, case No. .... Contusion of head with scalp wounds saloon brawl	9.00	
Oct.	5—To 22 days' hospital care, at $1.50, case No. .... Crushing injury, tramp; Railroad injury, riding on bumper.	33.00	
		$ 99.00	
	Balance	$ 1.00	
		$100.00	$100.00

Form number six shows another donation of equal amount, but with results differing greatly from those given in form number five. None of the persons benefited had any occupation, they were all a burden to society, well or ill; when restored to health none of them was capable of taking up a portion of the world's work, and by restoring them to health the institution simply increased the burdens of the community. In other words, this amount of money resulted in no actual good; in fact, it is likely that in a way the natural law of the survival of the fittest was artificially tampered with by the expenditure of this money.

It may be said that this is an uncharitable view of the case, but it seems reasonable to demand that some good should come from all charitable funds. Were all such cases utilized as clinical material for demonstrations before classes of students, or to be operated upon by them in order that they should become competent to treat properly the useful members of society after completing

their medical training, then the amount expended would result in sufficient benefit to society to make it worth while.

In the case of individual contributions a like statement should be rendered. It is most detrimental to the finances of a hospital to place all of the contributions to the institution into a general fund, and to use them promiscuously without accounting to any one for the direct application of any definite part of the money. Such a course will prevent persons who are not personally interested in the institution from filling charity beds with perverts, degenerates and habitual malingerers whose profession it is to spend much of their time in a hospital where they have been placed through the influence of some person who is more charitable than wise. Many institutions at the present time have a considerable portion of their resources diverted in this manner. Were a definite report made to each contributor indicating the results his contribution has accomplished, it is likely that much of this money would go toward restoring useful members of society to a condition which would enable them to earn the support of themselves and their families.

This especial feature is applicable to the conduct of hospitals under the management of church or charitable organizations in which a portion of the institution is given to the care of private patients, but does not apply to State, county or city institutions, nor to large hospitals which are entirely given up to the treatment of charity patients, because in these institutions the general report will have the same effect as the special reports in hospitals which are conducted partly for the care of charity and partly for the care of private patients. The same may be said of institutions conducted by various industrial corporations, each corporation contributing sums in proportion to the number of employes that are benefited by a given hospital. The plan is advisable in hospitals conducted by fraternal insurance societies for the benefit of wage earners, for then in each instance an interested person can determine the extent to which the institution has benefited its members.

BOOKKEEPING PROPER.

The past few years have developed a large number of systems of bookkeeping in which the card index plan is the leading feature. The number of books has necessarily been reduced and the amount of labor has been correspondingly decreased. By the introduction of ledgers with removable pages, the bulk of the ledger has been greatly curtailed and the entire system very much simplified. Any one of a number of these modern forms will serve

the purpose adequately. Most of these systems have been patented, and it would scarcely be proper to introduce the name of any one of them, but in connection with every institution there is some one who employs these modern forms of bookkeeping in his private business, and it will be an easy matter to make the necessary changes which are indicated to render one of these systems perfectly applicable to the needs of a hospital; moreover, the proprietors of these various systems are willing to furnish experts to assist in the adjustment of a system to the conditions in any given case.

FINANCIAL SUPPORT OF HOSPITALS CONDUCTED BY CHURCH OR CHARITABLE ORGANIZATIONS.

The source of the financial support will depend largely or entirely upon the character of the institution, which, if a public institution, must necessarily depend upon the State, county or city, the money being collected in the form of taxes. Under such circumstances the Superintendent should prepare a requisition to present to the proper authorities. This requisition should set forth the amount of money needed for the maintenance of the institution, for repairs, and for additional buildings in case these are required. The sum set aside for the maintenance of the institution for the ensuing year should be determined by a legislative body, the State, county or city, and the expenditure should be regulated so as to remain reasonably within the limits of the annual appropriation, except in case of epidemics and various catastrophies which might justify the Superintendent of the hospital in going beyond the appropriation for the year.

In hospitals conducted by philanthropic or church societies there are three regular sources of financial support. First, there is usually a membership fee, which may be applied to a general fund for the care of charity patients, or it may be applied to a fund provided for the care of the sick members of the association. Second, these institutions usually have a portion of the building set aside for the care of private patients, and the income paid by these patients for hospital care provides a considerable portion of the money used in conducting the institution. The third source comes through voluntary contributions without reference to membership.

FUNDS PROVIDED FROM MEMBERSHIP FEES.

The amount of energy that has to be expended in securing the annual membership fee is usually considerable when compared

with the financial results. It is doubtful if any institution in this country ever flourished under this system alone.

In organizing a hospital in which the membership fee is expected to defray a considerable portion of the current expenses, the following form has been found to be the least objectionable.

Name No.

Address

Date when		due	Form of membership	Folio	Amount		Date of Ck.		Amount	
Jan.	10	1901.	Semi annual dues	1	6	00	Jan.	12	6	00
July	10	1901.		1	6	00	July	15	6	00
Jan.	10	1902.		1	6	00	Jan.	14	6	00
July	10	1902.								

The amount of the annual membership fee should be sufficient to produce in the aggregate a considerable fund. Experience has shown that it is quite as easy to secure memberships with the annual fee of ten dollars as it is with a smaller fee. A record of the members and their payments should be kept in the card index, and also in the cash book of the association. The card index is arranged according to the months of the year, the cards being grouped during the months in which the annual contribution becomes due in each individual case. When the card of the person whose name it bears indicates that the annual fee becomes due the following month, a letter is sent to such member stating the date on which his annual contribution becomes due. This letter should inclose a blank check payable to the treasurer of the association. It should bear on its face the amount of the annual fee, and the date on which it becomes due. A blank is left for the member in question to fill in with the name of the bank on which the check is to be drawn. The letter should also contain an envelope addressed to the treasurer of the association.

Many contributors who might lay aside a simple announcement of the fact that their contribution is due will fill out and mail this check at once, because of the convenience of the system. Some of the members will prefer to substitute their own checks for those that have been sent to them. The cards of those who do not

remit should be kept in a separate file and such members should be again reminded of the fact that their remittance is due with sufficient force to bring results.

The same system can be applied for the purpose of securing the funds to support a hospital conducted for the benefit of wage earners. In this case there will be greater difficulty in collecting the necessary funds unless the corporation by whom these wage earners are employed has an arrangement with its employes according to which a certain portion of the wages is deducted each month, and transferred to the hospital fund. The amount collected from each wage earner should not be less than one dollar per month. In case the amount collected is in excess of the necessary expenditure, a sinking fund should be established for the purpose of constructing new buildings, and for use in case of some extraordinary emergency.

The system of conducting hospitals after this plan must ultimately result in great benefit, because of the possibility of obtaining treatment and care for the sick at a reasonable expenditure of money. The fact that the individuals who pay for this care will receive it for themselves and their families makes such a system most praiseworthy. At the present time, however, this plan has not attained any great degree of usefulness, and it will require the earnest endeavor of medical men of the highest business and professional qualities to develop the possibilities of this class of hospitals. There are a few instances, it must be acknowledged, in which a remarkable degree of success has been achieved by institutions of this class, so that those who are interested can have some precedent for their guidance.

INCOME FROM PRIVATE FUNDS.

The income from private patients depends largely upon the medical staff. If the members of the medical staff of the institution have a sufficiently large and profitable practice to enable them to send many well-to-do patients to the hospital, then a sufficient amount of money can easily be realized to defray the entire running expenses of the institution, supplying the care not only for the private patients, but also for the charity inmates.

Under this plan it is necessary to have three grades of patients: Those that pay a sufficient sum to the institution for their maintenance and to provide a profit. These patients should be known as private patients. The second class of patients pay less than enough to defray the expense their care incurs upon the institution; and these patients should be known as part charity patients. The third class, which can contribute nothing toward their support,

should be known as full charity patients. This plan has been found satisfactory in most communities in this country except in very large cities. A hospital obtaining its support in this manner fairly enters the field of competition upon its own merits.

There are two dangers to which institutions of this class are exposed: First, in their becoming purely money-making institutions and thus losing the primary object for which they are intended; the second danger may come from the selfish tendency of some members of the staff which will either result in financial embarrassment of the institution, or it will unfairly burden the more generous members of the staff.

There are in every community a number of patients requiring hospital care who have but a small amount of money at command. If these patients are sent to hospitals which obtain their financial support in the manner just described, it is important to the existence of the institution that they be sent early before their limited means is exhausted so that they will be able to pay in part or in whole for the care they receive. This must necessarily result in a certain degree of hardship to the attending physician, but under existing circumstances he will have to make this sacrifice in order to preserve the institution in which he is interested.

SELECTION OF CHARITY PATIENTS.

At this point it becomes necessary to digress in order to establish a basis for the above classification. The first class will be self-selected patients who are financially able to pay for their care, and who will choose rooms that will give them the comforts and even luxuries they would desire were they selecting lodgings at a hotel. The amount charged for such accommodations varies with the size and location of the rooms. An additional charge is made in case the patient desires a special nurse who will give all of her time and attention to this particular patient. These charges must necessarily vary with the conditions under which the hospital exists, precisely as the prices of rooms in hotels vary in different cities. In the smaller cities the price should be from two to four dollars a day, with an additional charge of from one and a half to three dollars per day for a special nurse. In a few of the larger cities in the country it is reasonable to charge from three to seven dollars per day, and from three to five dollars per day for special nurses.

The second class of patients should comprise patients who have small personal incomes, or whose hospital expenses are defrayed by friends or relatives. They should pay from one to two dollars per day for their hospital care.

The third class of patients—those unable to pay at all—should be very carefully selected, because it is in the selection of this class that disastrous errors in administration are most likely to occur.

There are several important considerations governing the admission of this latter class, quite irrespective of the so-called charitable character of the hospital.

In the first place, such patients should be selected with reference to the curability of the malady from which they are suffering; second, with regard to the fact whether or not they have been in some capacity useful members of society; and third, whether they are at the time unable personally to pay for their hospital care, or have friends or relatives able or willing to pay for it for them, or whether or not they belong to any association which protects them in case of sickness by paying for such care.

It is of the greatest importance in the conduct of hospitals, except in those that are conducted for incurable patients, that only those patients are admitted whose diseases can be classified as curable. If this precaution is not taken, the hospital will soon be filled with patients who are benefited only because of the fact that they receive their board and lodging for an indefinite period of time. It must be remembered that the hospital is equipped, not as a boarding house, but as an institution for the *cure of disease.* If it is filled with incurables, the very object of its existence is at once abolished and it becomes useless as a hospital proper.

SELF-MAINTENANCE.

It is, of course, important to the success of a hospital to have every person who can possibly do so pay for his cure, either directly by himself, or through his friends or some association. This condition of independence makes the patients far more appreciative of what is done for them both at the time they are in the hospital, as well as after they return to their homes. Institutions in which the greater portion of the patients do pay for their care are certain of much more prosperity than their competitors who supply free maintenance to patients who could provide for their own support if they but chose to do so. This natural condition contains direct application of a principle which is very old. The patient who is given free service when he is capable of self-support sacrifices his self-respect and looks upon what he receives in the way one looks upon what has of late been described as "graft." It is unnatural that any one receiving this graft should respect either himself or those who dispense it, consequently if one had no object in mind except the desire of self-preservation, it would still

be important to employ as far as possible the principle of making patients self-supporting as regards their hospital maintenance.

POVERTY.

The greatest abuse in the financial management of hospitals comes from the faulty selection of charity patients. Great sums of money are annually expended for the care in hospitals of patients who are not morally entitled thereto. All hospital authorities can recall many instances of patients who have abused this privilege. To avoid this, some institutions have established printed forms, which are filled out in accordance with the statement of the patient regarding his name, address, occupation, age, duration of illness, and his financial standing. The patient also states directly that he is entirely incapable of paying for his hospital care. He signs this statement, which is also signed and witnessed by the official of the hospital who receives it. If the patient has made false representations he is liable to punishment for obtaining money under false pretenses. The patient should give as reference two reliable persons with whom the hospital authorities can communicate. If there is anything suspicious in the reports of these references, the matter should be examined and the patient prosecuted so that the institution may obtain credit for enforcing honest dealing. It will never be possible to entirely prevent mistakes in this direction, but the amount of abuse of free hospital privileges can be reduced to a minimum.

It may be worth while to use a few authentic illustrations to show the extent to which such abuse may be employed. A person appearing like a farm laborer brought his son to the hospital, stating that he had been referred by a neighbor who had praised the surgical treatment and the kindness he had received from those connected with the institution. The neighbor had received his treatment and care free of charge, which was a further reason why the person under consideration desired to bring his son to the hospital. Investigation showed that the father of patient number two owned three thousand acres of land in a vicinity where land sold for a little over one hundred dollars per acre. This item of his estate alone equaled more than a quarter of a million dollars, and yet the man and his son had the appearance of poor farmers. If this case had not been investigated the hospital authorities would undoubtedly have felt that they had bestowed their charity worthily.

Another instance occurred in which a married woman had received free care at one of the well-known hospitals. When she

was ready to leave the hospital her husband came to take her home. He discovered that no one had taken the trouble to investigate his financial condition, and so invested the sum of three hundred dollars in an ornament for his wife, which he foolishly presented to her before they left the hospital, thus unintentionally bringing about an investigation which proved him amply able to pay liberally for the care his wife had been given. Such instances could be enumerated indefinitely. Occasionally it happens that patients who accept such free treatment are entirely ignorant of the wrong they have done to the institution, to the community and to themselves, for the reason that they have not given the matter the slightest thought. On the other hand, hospital authorities are often so anxious to fill the institution with patients that they do not take the trouble to institute the necessary investigation of the financial condition of any patient who may apply for hospital care. It also happens that members of the medical staff are often overzealous in obtaining interesting cases for their various departments, and for this reason they fill their wards with undeserving free patients. Ultimately this must result in an endless amount of harm to every one concerned.

VOLUNTARY CONTRIBUTIONS.

In the great cities and in the older small ones it is not necessary to obtain funds for maintaining the hospital through membership fees, because the greater portion of the money can be obtained from contributions by philanthropic persons. Experience has shown, however, that unless it is possible to secure large donations from single individuals, it is much better for the continued prosperity of the institution to obtain its financial support in the manner indicated above.

It is important to make a definite distinction between the money which has been contributed for the purpose of defraying current expenses and that which has been given expressly for the purpose of establishing endowments. It may be as much of a hardship for a hospital to exist without consuming any portion of its endowment fund, as it sometimes is for an individual with a definite income to live within his means. A lack of appreciation in either case must result in financial ruin.

It is proper in some instances to utilize money in the endowment fund for the purpose of erecting buildings, but this is the case only when a sufficient income from other sources is at hand to provide for the current expenses of the institution. In such a case the use which is made of the endowment fund would correspond to the borrowing of money for construction purposes. The inter-

est on the money representing the amount of the endowment should be paid into the maintenance fund from whatever source the interest on the endowment may have been provided for. In this manner the income will actually serve the purpose for which it was intended. Unless an endowment is cared for precisely in the manner in which an estate held in trust should be managed, the result must necessarily be as disastrous to the finances of the institution as would be careless administration of an estate. There is, however, this difference, ordinarily the funds of a spendthrift son of a wealthy father cannot readily be replenished after the estate has been squandered, while in the management of hospital endowments new endowments may be secured to replenish the empty treasury after the same principle has been applied.

The bequests in favor of hospitals always increase with the age of the institution, if the latter provides good care for the patients. Because of this fact even badly managed hospitals may be fairly prosperous, but it can easily be seen that with the elimination of these faulty elements in the financial management, the prosperity must be vastly increased. It has been demonstrated in a number of instances that these latter institutions have been able to accomplish a much greater amount of actual charity than other institutions which have received many times as much money in the form of donations or bequests. A study of these particular instances shows that in every case there is at least one member of the Board of Trustees who has been unusually successful as a business man, and who insists upon the use of the same sterling principles in the management of the hospital that have determined his prosperity in his business enterprises.

OTHER METHODS OF APPLYING ENDOWMENT FUNDS.

In the older hospitals in which the entire plant has been constructed there is, of course, no occasion to loan any portion of the endowment fund to the fund for buildings and equipment. In these institutions it is of the greatest importance to arrange matters so that only the income from the endowments is used for current expenses. This may seem like a hardship to institutions with a large endowment fund and a small appropriation for current expenses, but if the endowment itself is drawn upon for expenses, it will not take long to cripple the finances of the undertaking. If more than the income is consumed each year, the result must be identical with that which befalls any other enterprise in case the managers should live beyond their means.

In order to have a definite income the endowment funds should be invested in absolutely safe securities which will be sure to

yield a certain fixed sum for an indefinite period. Such securities will not, of course, bring so large an income as might be obtained were the money invested less securely, and less permanently, but it is easier to maintain the prosperity of an institution with a moderate income that can be depended upon than with a larger and uncertain one. Experience has shown that institutions which live strictly upon their legitimate incomes find it much easier to practice economy in management than do the institutions which consume for current expenses the money which is intended for endowment funds. This is illustrated most forcibly in a study of the finances of various hospitals with a view to determining in each instance the items which have consumed most of the means.

In the institutions which live within their means, such items as milk, meats, linen and surgical dressings cost much, relatively, while drugs, surgical instruments, office expenses and luxuries consume relatively little.

In hospitals which live beyond their means, quite the opposite is true. This can be explained in the following manner: The institutions of the first group expend their money for things which serve to benefit the patients, and thus secure a reputation for the institution in the proper direction. Those of the second group follow the whims of the persons in every department, each one knowing that the amount of money expended is entirely immaterial to him personally; as an instance, all kinds of untried and expensive instruments and drugs are ordered and never used, which, of course, greatly increase the total amount of money expended. As a matter of observation, it may be stated that the hospitals of the first group always compare favorably, in every way, with those of the second group.

ACTUAL COST OF CONDUCTING HOSPITALS.

It is customary to determine the cost of maintaining hospitals by taking the expense during the entire year and dividing it by the number of days of treatment which has been given to patients during the year. In case the hospital is divided into private rooms, and private general wards, an attempt is sometimes made to determine the relative cost of maintenance of each of these groups. To this should be added the interest of the amount expended in constructing and furnishing the hospital.

There is a marked difference as regards the daily cost of maintenance in different institutions. The cost varies from sixty-seven cents to two dollars and eighty-seven cents per day, according to the reports of the various American hospitals. There are a few of the best managed State hospitals in this country in which

the maintenance per day costs very much less than the minimum figure quoted, but in these institutions a number of important items of expense, such as milk and cream, poultry and eggs, beef, mutton and vegetables, are produced on large farms connected with the hospital, so that a fair comparison cannot be established. It will consequently be best to take the sums of sixty-seven cents, and two dollars and eighty-seven cents as the minimum and maximum expense per day in hospitals situated under usual conditions. To this must be added the interest of the money expended in constructing and furnishing the hospital. Here again we take the maximum and minimum amounts, which have been shown in a previous chapter of this work to vary from one thousand to ten thousand dollars per bed. In case the hospital has cost one thousand dollars per patient, the interest for the year will amount to forty dollars, or a little more than ten cents per patient per day. In case it has cost ten thousand dollars per patient to build and equip the hospital, the interest will amount to four hundred dollars a year for each patient, which is a little more than one dollar and nine cents per day. Adding these sums to the daily expense of maintenance will give the astonishing results of approximately one dollar per day in the one instance, and in the other nearly four times that amount. Singularly enough, a careful investigation of the care given to patients in these two classes of hospitals often demonstrates that in the hospital spending the smaller sum it far excels that given in institutions expending the larger amount, thus proving the fact that the difference is the result of waste in the one instance, and economy in the other.

A reasonable sum per day in hospitals caring for all its patients in large wards should vary from one dollar to one dollar and twenty-five cents. In hospitals in which all the patients are cared for in private rooms, the cost should vary from two dollars to two dollars and fifty cents per day. If a larger sum than this is expended there is invariably either unnecessary waste or undue luxury. This, of course, does not apply to the very beautifully appointed hospitals which are conducted by their owners as fads. Any amount of money can be paid for luxuries in such hospitals with perfect propriety, precisely as one could properly expend any amount of money in managing a private mansion.

FINANCING PRIVATE HOSPITALS.

In financing private hospitals it is necessary to organize in the same manner as in other enterprises. Provision must be made for construction and equipment, and for at least three-fourths of

the amount required for maintenance during the first year, one-half of the amount required for the second, and one-fourth for the third year. In a few rare instances private hospitals have paid their running expenses during the first year, and have yielded a profit after that, but this is the exception.

It is probably best to capitalize the undertaking to one-half the valuation of the land, buildings and equipment, and to provide for the issuing of bonds for the remaining half. It is, however, necessary to add at least fifty per cent. to the estimated cost. For instance, an institution whose estimated cost of construction, equipment and maintenance for the first three years amounts to one hundred thousand dollars, should sell stock at par for seventy-five thousand dollars, and bond at par for an equal amount. This will leave a sufficient margin for safety. There will, of course, be no dividends for at least five years, and later, although the earnings be as high as from ten to twenty per cent. on the entire investment, the dividends should only equal the current interest rate on the money. The remaining portion of money should be used for the purpose of retiring the bonds. These bonds should be made payable in twenty or thirty years, and they should contain a provision enabling the Trustees of the hospital to retire them at any interest-bearing date at their option, by giving due notice to the bondholders.

ORGANIZING HOSPITAL STOCKS AND BONDS.

At the present time members of the medical profession have the reputation of being one of the least competent portions of society in the management of business affairs, consequently large investors are not likely to purchase stocks and bonds the proceeds of which are intended for the purpose of constructing and maintaining a hospital. It is consequently necessary for the members of the medical profession interested in a given institution to purchase these stocks and bonds themselves, or to place them with personal friends who may be interested in such an institution perhaps for the benefit it would be in the community. It is wise to arrange matters so that each interested person subscribes for an equal amount of the stocks and bonds. The portion invested in bonds will be returned, leaving each investor with just one-half of his investment to provide for the contingency of depreciation of the property which may occur later or when other hospitals, more modern, appear to compete with the original one. Since hospitals are now uniformly built with fireproof construction, this element of competition is not so great as in years past, still it is well to take this precaution. There is a further advantage in this

precaution. Usually the stocks and bonds are subscribed for by prospective members of the medical staff, and should one of these members withdraw after the institution has been conducted for a number of years, this arrangement will make it much easier to dispose of his portion of the stock. Were this proportion in holdings in stocks and bonds not maintained, there would not be the same tendency toward liquidating the indebtedness, because the stockholders might prefer to take the profits of the institution in the form of dividends instead of applying it to the retirement of the bonds. In institutions of this kind it is always important that the stock be placed in friendly hands. By following the plan indicated above, this can be done more easily than in any other way. Just at present this system gives rise to a certain amount of abuse wherever these institutions exist side by side with those that are charitable or semi-charitable, because members of the staff of these private hospitals are often at the same time members of the staff of the two other institutions, which depend in part for the money they receive from patients who are able to pay for their care. Naturally the patients who are able to pay a large fee for their hospital care will be sent to a private institution, while those able to pay but a slight amount or nothing will be sent to the other institutions, thus increasing the burdens of the latter beyond that which would be natural under the conditions existing in the different locations. One can readily see that such slight matters of injustice must occur, and that they will be adjusted spontaneously as the development of the institution progresses. It is not unlikely that this development will occur in the following manner: Institutions which are now semi-charitable will establish pavilions, or different portions of the institution, such as complete floors in the many storied hospitals, will be given entirely to the care of private patients; then the medical staff caring for patients in the portion of the institution devoted to charity will be compelled to place their pay patients in departments of the same institutions which are devoted to private patients. On the other hand, there will be hospitals devoted entirely to the care of charity patients, and members of the medical staff of these institutions will be permitted to place their private patients in private hospitals conducted by corporations.

PHYSICIANS' FEES.

In connection with the discussion of hospital finances it seems proper to consider the subject of physicians' fees.

At a time when only patients whose poverty compelled them

to ask for hospital care there was, of course, no occasion to discuss the subject of physicians' fees, because any patient who possessed means with which to pay a physician for his services would not be found in a hospital. In the older cities in this country there are still many institutions which date back to this period, and they usually have prevented the attending physician or surgeon from accepting remuneration for his services to patients. In the meantime many of these institutions have developed into palatial establishments which are now occupied not only by the poor, but also by those who are well able to pay for any services they may receive. It is plain that with the changed conditions a change in these matters must also occur, but as a result of the old system the poor have been splendidly housed in these great hospitals, while the wealthy have been compelled to be satisfied with the inefficient and unsatisfactory conditions which could be offered to them in their own homes, or, if they went to hospitals for treatment, they were placed in "nursing homes," which take the place of private hospitals in the older cities of this country. These usually consist of old, abandoned dwelling houses in which the plumbing, heating and ventilation are antiquated, and in which none of the modern hospital conditions are present. Were the physician to place his patient in the modern hospital, to which he sends his charity patients, he would at once deprive himself of a proper remuneration for his labors. In this manner the patient who pays for his care and the professional skill does not receive the quality to which he is entitled, and the physician's efforts are greatly increased by the inconvenience to which he is exposed in treating his patients under these unfavorable conditions.

It is likely that there will be established a grading of patients with respect to professional fees into those who pay full fees, those who pay partial fees, and those who are treated entirely free. It is reasonable to expect that those who are able to pay for services should be permitted to do so, and that those to whom a regular fee would prove to be burdensome should have a smaller fee, one which will be quite within their means. They should receive precisely the same care as do patients who pay a regular fee. Those who are entirely unable to pay should have their medical and surgical treatment free of charge, and the quality of the treatment should still be the same, but in partial recompense the community at large should be benefited by having such cases utilized for the purpose of instructing medical students and young practitioners, provided always that this be done with due consistency to the patient.

The matter of fees should be left to the members of the staff. If, however, the members abuse this privilege they should be removed, and physicians less selfish appointed in their places. The question of fees is one of the most difficult to handle with justice to the patient and to the physician. It is usually best to leave the matter entirely with the physician and the patient.

No charge should be made by the attending physician or surgeon to charity patients in mixed hospitals, or in hospitals devoted exclusively to the care of charity patients.

LIST OF ILLUSTRATIONS.

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